Iron and Steel Engineer

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T. B. LITTLE, EDITOR

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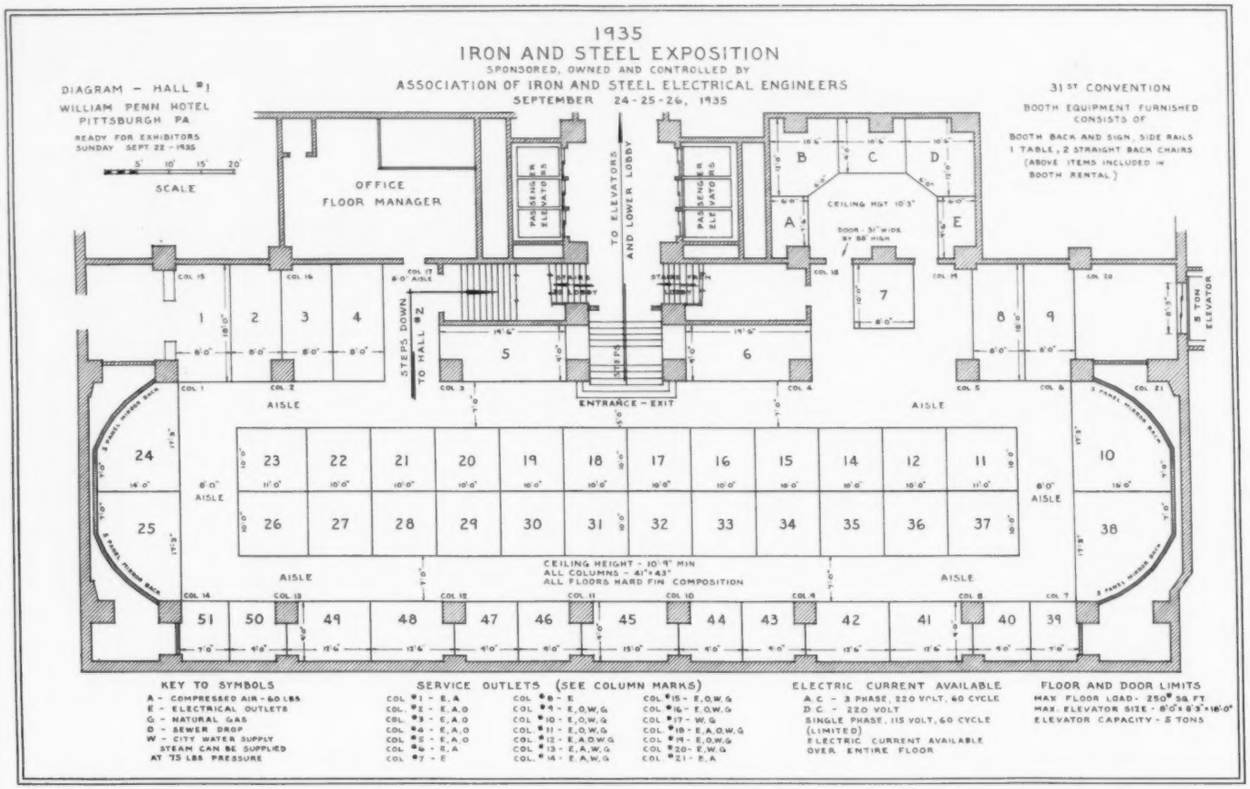
1935
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SPONSORED, OWNED AND CONTROLLED BY
ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS
SEPTEMBER 24-25-26, 1935
DIAGRAM - HALL #1
WILLIAM PENN HOTEL
PITTSBURGH PA
READY FOR EXHIBITORS
SUNDAY SEPT 22 - 1935
SCALE
OFFICE
FLOOR MANAGER
PASSENGER ELEVATORS
TO ELEVATORS AND LOWER LOBBY
STEPS DOWN TO HALL #2
ENTRANCE - EXIT
AISLE
CEILING HGT 10'3"
DOOR - 5'-0" WIDE BY 8'0" HIGH
5 TON ELEVATOR
CEILING HEIGHT - 10'-9" MIN
ALL COLUMNS - 41"x43"
ALL FLOORS HARD FIN COMPOSITION
31ST CONVENTION
BOOTH EQUIPMENT FURNISHED CONSISTS OF
BOOTH BACK AND SIGN, SIDE RAILS
1 TABLE, 2 STRAIGHT BACK CHAIRS
(ABOVE ITEMS INCLUDED IN BOOTH RENTAL)
KEY TO SYMBOLS
A - COMPRESSED AIR - 60 LBS
E - ELECTRICAL OUTLETS
G - NATURAL GAS
D - SEWER DROP
W - CITY WATER SUPPLY
STEAM CAN BE SUPPLIED AT 75 LBS PRESSURE
SERVICE OUTLETS (SEE COLUMN MARKS)
ELECTRIC CURRENT AVAILABLE
A.C. - 3 PHASE, 220 VOLT, 60 CYCLE
D.C. - 220 VOLT
SINGLE PHASE, 115 VOLT, 60 CYCLE (LIMITED)
ELECTRIC CURRENT AVAILABLE OVER ENTIRE FLOOR
FLOOR AND DOOR LIMITS
MAX FLOOR LOAD - 250# SQ FT
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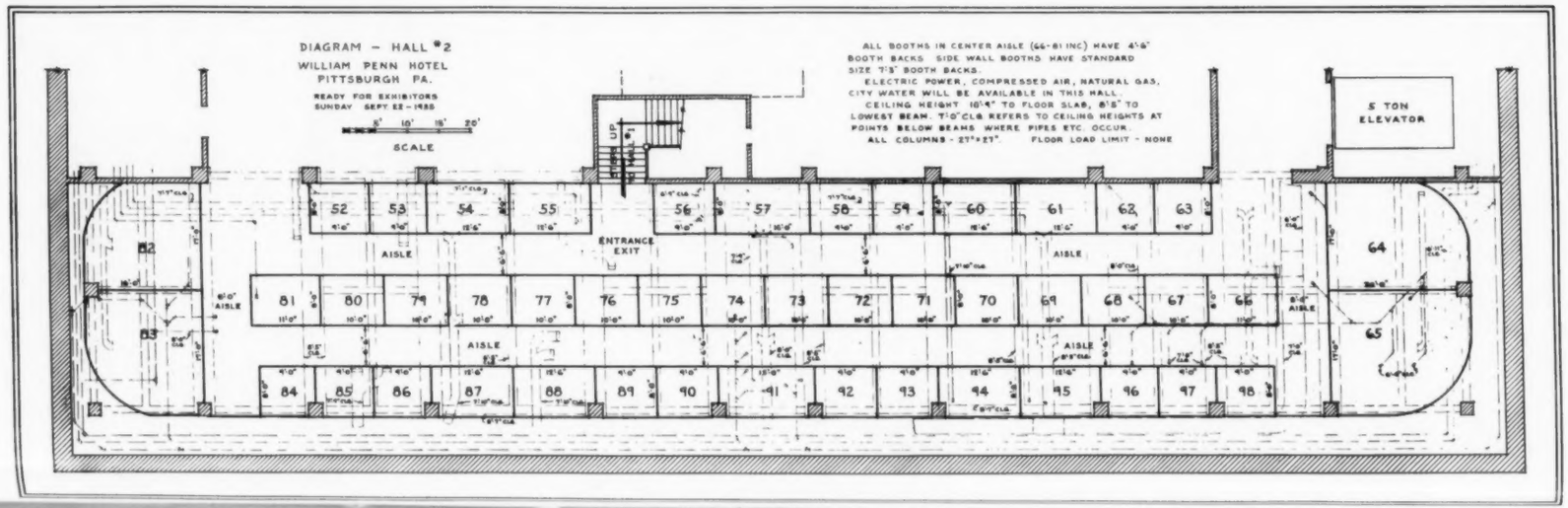
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WILLIAM PENN HOTEL
PITTSBURGH PA.
READY FOR EXHIBITORS
SUNDAY SEPT 22 - 1935
SCALE
ALL BOOTHS IN CENTER AISLE (66-81 INC) HAVE 4'-6" BOOTH BACKS. SIDE WALL BOOTHS HAVE STANDARD SIZE 7'-3" BOOTH BACKS.
ELECTRIC POWER, COMPRESSED AIR, NATURAL GAS, CITY WATER WILL BE AVAILABLE IN THIS HALL.
CEILING HEIGHT 10'-9" TO FLOOR SLAB, 8'-5" TO LOWEST BEAM. 7'-0" CLR REFERS TO CEILING HEIGHTS AT POINTS BELOW BEAMS WHERE PIPES ETC. OCCUR.
ALL COLUMNS - 27"x27". FLOOR LOAD LIMIT - NONE
5 TON ELEVATOR
ENTRANCE EXIT
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EDITORIALS

A. I. & S. E. E. TWENTY-EIGHTH ANNIVERSARY...

This month of April celebrates the twenty-eighth year of service our society has contributed to the steel industry. Little thought the pioneering members of the association when they gathered at the plant of a prominent manufacturer of steel mill electrical equipment, some twenty-eight years ago, where the idea of a collective agency for a discussion of their mutual problems germinated, that it would grow into an organization that has contributed more to the advancement of the steel industry than any other organized group of men.

Over the span of the past twenty-eight years there has been many changes in the association. From the original electrical section, upon which the society was founded, there has been added the mechanical, safety, lubrication, welding, and combustion engineering divisions. These progressive movements have enabled the society to take a high place with the other engineering societies in this country.

Men of vision who realized the necessity of keeping abreast of the industry in its forward march guided the association into its present state of prominence. As the industry has broadened its application of modern machinery and methods so has the society kept pace by widening its scope of activities to help promote the advancement of all forms of engineering to the iron and steel industry.

* * * * *

SPRING ENGINEERING CONFERENCE...

Elsewhere in this issue may be found a special 24 page section devoted to the annual Spring Engineering Conference of the society. This meeting which is sponsored by the combustion engineering division, is to be held in Youngstown, Ohio, April 24 and 25 at the Ohio Hotel.

Under the guidance of the committees a very attractive and well balanced technical program has been arranged. The subjects were chosen with particular care to see that the most pertinent would be brought up for discussion. Among which are the maintenance of roll neck bearings, broad strip mills, heating furnaces, soaking pits, electrical equipment, natural gas in steel plants, and design and operation of open hearth furnaces.

Particularly stimulating while making the arrangements for this conference has been the helpful attitude of all the leading steel mill officials in the Youngstown district. Realizing the fact that they have one of the most prominent steel centers in the world, the Youngstown steel mill executives have left nothing undone in their efforts to justify this position in aiding the society to promote a successful meeting in their city.

* * * * *

IRON AND STEEL EXPOSITION...

Shown on the opposite page is the complete floor plan of the A. I. & S. E. E. Iron and Steel Exposition to be held in Pittsburgh, September 24, 25 and 26, 1935 at the William Penn Hotel.

At the present time all of the booths in hall number 1 have been reserved and in hall number 2, fifty per cent of the space has been taken.

There has been an unparalleled demand for space this year in our exposition which speaks well not only for the prestige of our annual steel mill show, but also for the faith the manufacturers of steel mill equipment have in the future of the steel industry as a market for their products.

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Propane and Butane As Industrial Fuels

By E. A. JAMISON
Eastern Manager, Phillips Petroleum Company, Philadelphia, Pa., and
W. H. BATEMAN*
Manager Propane Dept., Sun Oil Company, Philadelphia, Pa.

Paper presented at the A. I. & S. E. E. Annual Convention held in Cleveland, Ohio, September 18, 19 and 20, 1934.

E. A. JAMISON

W. H. BATEMAN

Many advances in fuels and methods of firing have been made during the past ten years—modern, more efficient fuels and methods of firing have replaced cruder forms of fuel and less efficient methods of combustion. One of the most outstanding developments has been the advent and wide spread adoption of the liquefied petroleum gases, propane and butane, as industrial fuels.

An examination of Fig. 1 shows these gases to be pure hydro-carbons, propane C_3H_8 and butane C_4H_{10}. Ethane is present in relatively small amounts and since some prevailing atmospheric temperatures are above its critical range, therefore, the ethane present will be held mainly as dissolved gas. The major compounds, propane and butane, are on the border line between liquids and gases; that is, they are gases under normal conditions but readily condensible under the proper conditions of temperature and pressure. It is this property that renders these gases or mixtures of these gases, valuable as fuels as they may be handled, transported and stored with the convenience of a liquid but on the other hand, it is possible to distribute and burn them with all the convenience of gases.

The major differences between propane and butane exists in the boiling point, vapor pressure and B.T.U. per gallon. Both gases are hydrocarbons of the same family and noncorrosive, and in commercial grades have exceptionally low sulfur content.

The estimated available supply of liquefied petroleum gases from natural gasoline source is in the neighborhood of 750,000 gallons per day. There is also an estimated potential supply of about 2,000,000 gallons of butanes available from refineries, one-half of which is going at present into motor fuel. There are many reasons for believing that all of these butanes will eventually go into motor fuel as gasoline of higher vapor pressure becomes usable in automotive equipment. The same refineries have an estimated available propane production of approximately 800,000 gallons per day. As a result of this situation, most of the butanes will be eventually supplied from natural gasoline sources and the propane from the sources of the most economical transportation. Some refineries are contemplating offering a variable mixture of propane and/or propylenes, butanes and/or butylenes. This material, while inferior to the more closely controlled specification products, will be a potential competitor of specification grades of commercial propane and commercial butane.

* Now President, Solgas, Inc., Philadelphia, Pa.

At the present time there is an estimated ratio between the available production and consumption of about 25 to 1. Therefore, it is expected that prices of these fuels will remain relatively stable. It is true that there are many refineries that are in a position to manufacture these products but which do not, as yet, have the proper equipment installed for doing so.

For quite a period of years, heat treating operations have gradually become more exacting, where at one time it was considered that any fuel which would produce the necessary heat and was the lowest in cost per B.T.U. was the only fuel to be considered. It was soon found, however, that certain fuels had their limitations as to the quality of work which could be produced with them. Coal fired furnaces were changed to fuel oil firing and some of these were changed again to manufactured gas firing, or to electricity for heating. The final question resolves itself into finding a fuel sufficiently constant in composition and combustion characteristics to give a constant, uniform temperature and atmosphere within the furnace. With the appearance of liquefied petroleum gas, rapid strides have been made in solving the more difficult problems, such as bright annealing, (ferrous and non-ferrous metals), deoxidizing, carburizing, nitriding, forging and hardening without scale, etc., etc. Even though some manufactured gases, by a certain amount of treatment, can be used for these operations, liquefied petroleum gases have made these problems far simpler and have produced in the end higher and more uniform quality.

Propane and butane are shipped in special tank cars, constructed in accordance with Interstate Commerce Commission regulations. Four inches of cork insulation surrounds the tank, which is in turn protected with a metal jacket. Heating coils are located on these cars external to the shell, but under the insulation. All connections to the tanks are through the manhole cover plate, and protected by heavy housing.

These cars have a shell capacity of approximately 11,000 gallons which, when properly loaded, average about 9600 gallons. As these cars have no expansion dome, a space must be allowed for thermal expansion; therefore, the cars are filled to within approximately 12″ of the top, at 60° F.

In certain localities, these fuels are delivered in special tank trucks. The ones used by Sun Oil Company are the two compartment type, each compartment containing approximately 1000 gallons, which is the minimum quantity that will be delivered. The tanks are equipped with a motor-driven centrifugal pump which operates from the truck engine generator set. This pump takes the place of the tank car unloading pump, in larger installations. Due to the weight of these trucks with relation to the pay load, it is not now feasible from the standpoint of economy to make hauls of much over 100 miles from the source of supply. The use of trucks for delivery of liquefied petroleum gas to industrial plants opened up a new field; namely, industrial plants whose gas consumption was not great enough to warrant a large, tank car size installation, and plants not served by a railroad.

The hazards involved in the use of these gases are similar in nature to other inflammable material.

AVERAGE PROPERTIES OF LIQUEFIED PETROLEUM GAS PRODUCTS

	PROPANE	BUTANE
Vapor Pressure Lbs./Sq. In. Gauge	C_3H_8	C_4H_{10}
at 70°F.	122	31
at 90°F.	165	49
at 100°F.	190	59
at 105°F.	204	65
Specific Gravity of Liquid (60°/60°F.)	0.511	0.582
Initial Boiling Point at 14.7 Lbs./Sq. In. Abs. °F.	-51	15
Weight per Gallon of Liquid at 60°F., Lbs.	4.26	4.84
Dew Point at 14.7 Lbs./Sq. In. Abs. °F.	-45	24
Cu. Ft. of Gas at 60°F., 30″ Hg. Per Gallon of Liquid at 60°F.	36.18	31.46
Specific Gravity of Gas (Air=1) at 60°F., 30″ Hg.	1.53	2.01
Ignition Temperature in Air, °F	920-1020	900-1000
Maximum Flame Temperature in Air °F	3600	3615
Per cent Gas in Air for Maximum Flame Temperature, %	4.2-4.4	3.3-3.4
Limits of Inflammability in Air, Gas Per Cent in Gas-Air Mixture:		
At Lower Limit, %	2.4	1.9
At Max. Rate of Flame Propagation, %	4.7-4.9	3.7-3.9
At Upper Limit, %	9.6	8.6
Required for Complete Combustion:		
Cu. Ft. 0_2/Cu. Ft. Gas	4.9	6.3
Cu. Ft. Air/Cu. Ft. Gas	23.4	30.0
Lbs. 0_2/Lb. Gas	3.59	3.54
Lbs. Air/Lb. Gas	15.52	15.3
Products of Complete Combustion:		
Cu. Ft. CO_2/Cu. Ft. Gas	3.0	3.9
Cu. Ft. H_2O/Cu. Ft. Gas	3.8	4.6
Cu. Ft. N_2/Cu. Ft. Gas	18.5	23.7
Lbs. Co_2/Lb. Gas	3.0	3.1
Lbs. H_2O/ Lb. Gas	1.5	1.5
Lbs. N_2/Lb. Gas	11.9	11.8
Latent Heat of Vaporization at Boiling Point:		
B. T. U. per Pound	184	167
B. T. U. per Gallon	784	808
Total Heating Value(After Vaporization)		
B. T. U. per Cu. Foot	2537	3261
B. T. U. per Pound	21570	21180
B. T. U. per Gallon	91800	102600

FIG. 1.

In the gaseous state these fuels have a hazard comparable to manufactured or natural gas, but with the advantage of an extremely narrow inflammable range. Liquefied petroleum gases do not contain toxic carbon monoxide as is contained in unburned manufactured and producer gases. In the liquid state the hazard is similar to inflammable liquid, though somewhat modified by the rapid vaporization, particularly in the case of propane.

The National Board of Fire Underwriters have published Pamphlet No. 58 in an attempt to estab-

lish a uniform set of regulations governing the design, installation and construction of containers and other equipment for handling liquefied petroleum gases. Because of the general close adherence of the liquefied petroleum gas industry to these regulations, for which they were in a large measure responsible, the industry has been remarkably free of accidents.

Storage equipment is located not less than 50 feet from any important building or adjoining property line. This distance may be modified in some cases if containers are installed below ground. All filling and discharge pipes are provided with suitable, automatic, excess flow valves, to prevent flow if the line is broken. The tank is equipped with at least two safety valves, sufficiently large to prevent building up of pressure to any appreciable extent in case of fire from an outside source. Although these are the most pertinent major items, Pamphlet No. 58 completely covers all the details, such as fencing, painting, liquid transfer, holders, gauging devices, valves, fittings, filling levels, capacity and design pressures.

Storage tanks are fabricated according to the A.S.M. E. Code for Unfired Pressure Vessels. The size of tanks vary from 1350 gallons to 4000 gallons with tankwagon delivery and from 12,000 gallons to 25,000 gallons for tank car delivery, the maximum allowable size for a single tank. However, multiples of these sizes can be used if a larger installed capacity is desired. The installed storage is generally based on the plant load in relation to the distance from the source of supply.

Most of the installations for liquefied petroleum gas are made above ground because of the simplicity of inspection, the initial cost is lower, soil corrosion is eliminated and it is easier to determine the liquid level within the tank. Also the above ground tanks, in the case of propane, permit a greater rate of vaporization than do the underground tanks. When space is important, however, these containers are often buried.

These fuels may be transferred from the tank car by one of several methods, i.e., pumping, heating of the car to increase the pressure or by means of air or other inert gas pressure. The latter method is the one most commonly used for butane while propane is usually unloaded by pump. Pumping has an additional advantage as it provides a method for filling of cylinders in plants where the propane is used as a cutting fuel, where it is not distributed throughout the entire plant by pipe lines. The tank car and pump are generally connected with a hose especially made for this type of service. If air pressure is used, however, as in the case of butane, provision must be made to prevent the flow of the gas back into the air system. A positive displacement or rotary pump is especially designed to handle these liquids and is commonly used for both propane and butane. These pumps generally have a capacity of from 30 to 60 gallons per minute. In the case of tank truck deliveries the rotary centrifugal or positive displacement pump is mounted on the truck and transfers the fuel from the tank truck to the storage tank.

When using butane and with some installations having large hourly demands using propane it is necessary to supply the latent heat of vaporization by some outside source other than the atmosphere. When this is done the liquid is pushed from the storage tank by its own vapor pressure through a liquid eduction line to a heat exchanger. There are two types of heat exchangers in common use; the tubular type and the flash type, the latter of which is merely a shell with a concave plate separating the two heads. The pressure of the liquid passing into the heat exchanger is usually reduced to approximately 10 to 30 lbs. by means of a suitable regulator. These heat exchangers are supplied with either steam or hot water.

Usually at the outlet of the heat exchanger is the second stage of regulation which reduces the gas pressure to that required in the plant. In some cases these regulators are set for a relatively high pressure in order to use extremely small pipe lines or to get a greater capacity from the distribution system or, in other cases where a different pressure is required for various appliances in the plant to permit further pressure reduction. With butane it is undesirable to carry pressures too high on account of recondensation difficulties, whereas with propane, pressures as high as 35 lbs. are carried, in which case it may be used through the high pressure inspirator type of equipment.

Undiluted propane and putane have approximately the same combustion characteristics as natural gas, consequently, almost any equipment which will operate satisfactory with natural gas will also operate with liquefied petroleum gas. However, the difference in gravity and thermal value causes certain limitations in the type of inspirating equipment. This is particularly true of butane because of its high thermal value and pressure restrictions.

Broadly speaking, there are three types of gas combustion equipment, namely, atmospheric, low and high pressure. The atmospheric type of burner usually operates satisfactorily with propane at from 11 to 15 inches of water column pressure. Usually the conversion from manufactured gas can be made by changing the orifice size and slightly increasing the burner ports in order to take care of the difference in thermal value, gravity and rate of flame propagation. In the conversion of natural gas equipment, it is, of course, only necessary to change the orifice size as the rate of flame propagation is approximately the same as that of liquefied pertoleum gases.

There are many variations of the low pressure system but in general they all use air for combustion supplied at a few ounces to several pounds pressure. One of the most commonly used types is the one in which the gase is reduced to practically zero pressure and is induced by air under pressure passing through a venturi throat. This is commonly known as the low pressure proportional inspirator type.

The high pressure systems are the cheapest to install and the easiest type to operate but they are limited when used with liquefied petroleum gas to either propane or air-diluted butane. When using propane these systems generally operate at from 20 to 30 lbs. pressure but because of the higher dew point with butane and lower vapor pressure, it is necessary to first dilute it with air and then pass this mixture through a compressor. Industrial propane operating at 20 to 30 lbs. pressure is giving excellent results in the world's largest annealing furnace where sixty-two of this type burner have been in operation for more than a year. During the past year a number of industrial plants which formerly used manu-

factured gas, either supplied by the utility at high pressure or compressed the gas themselves, have successfully converted this equipment to use the high pressure industrial propane.

There are a number of other types of combustion systems such as the partial pre-mix and the total pre-mix, all of which operate equally as well with liquefied pertoleum gas.

In most cases the liquefied petroleum gases have replaced either manufactured gas or fuel oil and in a few instances producer gas, electricity, coal and coke. Among the general uses made of them include: Annealing furnaces, drying ovens, hardening furnaces, Japanning ovens, normalizing furnaces, forging furnaces, carburizing furnaces, lead pots, galvanizing furnaces, enamel burning ovens, core ovens, mold drying ovens, lithograph ovens, bread baking ovens, armature baking ovens.

Some of these furnaces are of the ordinary batch type, some of the rotary type and others of the continuous type. In many instances these fuels are used not only for supplying the heat to carburizing furnaces but also act as the carburizing medium. Large furnaces containing molten lead through which strip steel is passed for annealing are also fired with these fuels. Also, lead pots for hardening operations, die casting pots and die casting machines, automatic machines for soldering and sweating as in the can industry. They are also used in torches of various sizes, and types for such operations as brazing, soldering, cutting, drying and preheating. In the automotive industry they are used quite extensively for the block testing of internal combustion engines because of the low cost per therm, ease of adjustment, uniform composition and freedom from contamination. These liquefied petroleum gases are also found in a wide number of uses in the ceramic industry, on such operations as batch and continuous types of porcelain baking kilns and furnaces, for glost and bisque kilns as well as for frit smelting furnaces. Many miscellaneous uses are also made of these gases around the average industrial plant, i. e. such as laboratory equipment, ranges and coffee urns in cafeterias, water heaters, boilers and space heaters, welding of light weight sheet metal, pilot lights for oil burners, etc.

There is one application in particular which is always of interest to steel industries, i. e. gas cutting with oxy-propane. Although this particular field does not offer a large outlet to the marketer of these products it does offer quite a substantial saving to the user.

In one of the largest steel casting plants in the east, Industrial propane has replaced generated acetylene on all of the gas cutting operations. This work, of course, consists chiefly of cutting the risers and cleaning up the castings after removing them from the molds. The thicknesses cut vary from a fraction of an inch to about 27 inches. Many of these operations are particularly difficult because of the position in which it is necessary for the cutter to stand and also because of the large amount of sand clinging to the casting. Previous to the conversion to industrial propane it was possible to cut risers up to only a diameter of about 15 inches before following up with an oxygen lance. However, with the industrial propane they are now able to cut risers up to 21" in diameter before using the lance. It is understood

FIG. II.

June 22, 1934.

SUMMARY OF COMPARATIVE GAS CUTTING TESTS ON ROLLED STEEL PLATE. ACETYLENE VS. PROPANE.

(Machine Cutting)

Thickness of Material Cut—1¼" Plate.

	Average for 2 Acetylene Tests	Average for 1 Industrial Propane Test
Length (each) cut-inches	335½	335½
Time for Cut—Min.—Sec.	28–4	27–18
Free Oxygen Used—cu. ft	73.9	2.72
BTU Consumed per Cut	10,336	6,901

Thickness of Material Cut—4" Plate

	Average for 6 Acetylene Tests	Average for 2 Industrial Propane Tests
Length (each) cut—inches	84	84
Time for Cut—Min.—Sec.—	11–28	10–35
Free Oxygen Used—cu. ft.	53.3	52.9
Free Fuel Used—cu. ft.	3.98	1.72
BTU Consumed per Cut	5,962.04	4,363.64

Thickness of Material Cut—12" Plate

	Average for 1 Acetylene Test	Average for 2 Industrial Propane Tests
Length of Cut—inches	18	18⅜
Time for Cut—Min.—Sec.	5–57	5–45
Free Oxygen Used—cu. ft.	91.3	88.4
Free Fuel Used—cu. ft.	6.14	2.51
BTU Consumed per Cut	9,197.72	6,367.87

FIG. 2.

that the cost of the propane is approximately one-fifth of the cost of the generated acetylene for carrying on these operations. Somewhat contrary to theory and most particularly contrary to general belief it has been found that the oxygen consumption has not increased but has remained practically the same for a given amount of work as when using generated acetylene. This fact has been proven by approximately six months of actual operation

Another series of very interesting gas cutting tests on rolled steel plates was made at one of the largest eastern steel plants. The thickness of these plates varied from 1¼" to 12". To give some idea of the results, allow us to quote the figures obtained by the cutting of the 1¼" plate. There was a total of 335½ linear inches cut with each fuel, that is, oxy-acetylene and oxy-propane. The average time for this length of cut with the oxy-acetylene was 28 min. 4 sec., whereas with the oxy-propane it required 27 min. 18 sec. Here again it was found that the oxygen required for the oxy-propane cutting was not in excess of that required for acetylene but the opposite was true, namely, that there were 73.9 cu. ft. free oxygen required for the acetylene, whereas the propane required but 62.38 cu. ft. There were 6.9 cu. ft. of free acetylene used in making the cut with acetylene as compared with 2.72 cub. ft. free propane. However, allow us to reduce this to a thermal comparison in which we take BTU value of acetylene at 1498 BTU per cubic foot and the industrial propane at 2537 BTU per cubic foot. In this way it

showed that there were 10,336 BTU required with acetylene as compared with 6,901 BTU required in making the cut with propane.

A series of tests was also made in gas cutting of 4" and 12" plate and the figures were found to be comparable to those of the 1¼" plate. A summary of the figures is shown in Figure 2.

Industrial propane or industrial butane installations are usually justified on the basis of savings obtained by the use of these fuels in place of manufactured gas. The differential in cost between these fuels varies quite materially with the quantities involved and the locality, this range being from 25% to 75%. In addition to the savings there are many other advantages such as constant composition, constant gravity, constant thermal value and pressure is maintained constant by regulators which supply only the industrial plant in which the installation is made. These factors result in much greater ease of control of furnace temperature and atmosphere. Industrial propane and industrial butane are clean fuels and free of contamination. Because of the much higher thermal value, smaller pipe lines can be used or the existing pipe lines have an increased carrying capacity. Due to extremely low rate of flame propagation lower burner nozzle velocities are possible, thus reducing both backfiring difficulties and the maintenance of furnace linings. Usually after the installation has been completed and the manufactured gas replaced with the liquefied petroleum gas, at the average plant it is found that there are many heating operations which are being carried on with fuel oil or other fuels which can be replaced with liquefied petroleum gas at not only great substantial savings but also an increase in quality of product.

Liquefied petroleum gases have the following advantages over fuel oil:

1. No pumping required.
2. No steaming of tank car required for unloading.
3. No sediment or sludge as waste material.
4. Sulfur fumes eliminated.
5. No grease or dirt inside of buildings.
6. No smoke or soot when starting up furnaces.
7. Reduced maintenance on furnace refractories and alloy parts.
8. No sulfurization of alloy furnace parts.
9. Improved furnace control, both as to temperature and atmosphere.
10. Reduction in scaling of product.

Since the liquefied petroleum gases are used in their gaseous state, practically all of the combustion equipment designed for other gaseous fuels can also be used with these fuels. For most efficient combustion, however, minor changes are usually necessary. For instance, on the atmospheric type of equipment usually 11 to 15 inches of water column pressure is used with liquefied petroleum gas, whereas from 3 to 5 inches water column pressure is satisfactory with manufactured gas. Also, over the above mentioned advantages there are the usual and inherent advantages of the gaseous types of fuel to be had along with several other factors, such as constant composition and constant pressure. These latter two characteristics alone have led several engineers of large corporations to admit that they would be willing to pay more for the industrial propane or butane than was previously paid for manufactured gas. For industrial heating operations liquefied petroleum gas is generally lower in cost than the better grades of fuel oil. In many plants these gases have replaced fuel oil on account of the lower cost of the finished product which in the final analysis is what we desire. In other words, fuel costs cannot be determined by comparison of the BTU costs since there is such a great difference in burning efficiencies. Quality of the finished product, working conditions and maintenance also should be taken into consideration. Another item which is often overlooked is the higher available heat obtainable with liquefied petroleum gas as compared to other commercial fuels.

It is interesting to note that in the face of the low production of industry, there was a 12% gain in consumption of liquefied petroleum gases between 1931 and 1932, while there was a decided loss in volume in both the natural and manufactured gas industries.

During the past year, preference by the industrial plants for the use of Propane over Butane as a fuel has been in the ratio of ten Propane installations to one Butane. The trend is definitely toward the use of Propane as a liquefied petroleum gas fuel to industrial plants primarily because it has not only all the advantages of Butane (compared with other fuels, such as manufactured gas, producer gas, fuel oil, electricity, coal or coke) but in addition has certain definite advantages of its own as herein described.

DISCUSSION

Discussion Presented by

G. T. Hollett, Fuel Engineer, Illinois Steel Company, South Chicago, Ill. (Deceased)
W. H. Bateman, Manager, Propane Department, Sun Oil Company, Philadelphia, Pa.
H. V. Flagg, Combustion Engineer, American Rolling Mill Company, Middletown, Ohio.
C. A. Kral, Asst. Gen. Mgr., Wheeling Steel Corporation, Steubenville, Ohio.
C. T. Konecny, Columbia Engineering Corporation, Columbus, Ohio.

G. T. Hollett: The paper has been very interesting. Where you have free oxygen that comes from the air, I will agree with everything he has said. We have done considerable experimenting in our plant and we have proven in every case, to our own satisfaction, that we couldn't afford to use butane in place of acetylene, even for torch work at no cost to us. It can be proven theoretically that additional oxygen is required when using butane on account of the large amount of water vapor in the products of combustion.

I would like to ask what pressures you obtain in propane and butane storage tanks.

W. H. Bateman: Our first experience with liquefied gas as a cutting fuel indicated our oxygen consumption to be excessive. As we gained more experience as to the proper flame setting and better equipment our oxygen consumption came down to that when using acetylene. We believe this reduction in oxygen consumption to be partly due, if not wholly, to a decreased size of kerf when using propane. A large steel concern who has been using propane in place of acetylene for approximately one year tells us that their oxygen con-

sumption is now less than they previously experienced with acetylene.

The vapor pressure of butane is 71 pounds at 105 degrees F., propane 200 pounds at 105 degrees F. However, these pressures are very rarely reached even in the hottest summer days.

G. T. Hollett: We tried out several torches and these tests were made in conjunction with the manufacturers of the torches.

W. H. Bateman: Have you tried the Harris torch?

G. T. Hollett: No, we didn't.

W. H. Bateman: If you have not already tried the Harris torch, I think that it would be worth while investigating.

H. V. Flagg: I would like to ask a question as to the stability of supply with respect to location, price and time.

W. H. Bateman: Until the past few years the great bulk of propane and butane has been produced from natural sources. During the last three years the refining branch of the industry has made available for use the propane and butane included in refinery gas. However, the butane content of gasoline has been increasing each year, resulting in a reduction of butane available from this source. It is entirely possible that butane from refineries will vanish entirely leaving only propane available for general use. This will, of course, have a tendency to increase the butane available from natural sources. The price of liquefied gas has had a tendency to drop in recent years due to competition with other fuels such as natural and manufactured gas.

C. A. Kral: Just one question. Can you state approximately the actual price for one million B.T.U. delivered in this district, for instance? Say, Pittsburgh or Chicago. I am asking that question so we might compare it with emergency fuel, natural gas, etc.

W. H. Bateman: Liquefied gas would cost approximately 7 cents per 100,000 B.T.U. delivered into Pittsburgh in tankcars.

C. T. Konecny: What would be the dewpoint on a mixture, say of 20 per cent butane and 80 per cent air, at thirty pounds pressure?

W. H. Bateman: The dewpoint of a mixture of 20 per cent N-Butane carbureted with air at thirty pounds pressure gauge will be about 9 degrees F.

C. T. Konecny: In its use as a substitute or emergency fuel, would you recommend using it straight or using it with an air dilution?

W. H. Bateman: For a quick change-over from natural gas it would be necessary to send out a mixture of air carbureted with liquefied gas having roughly the same B.T.U. per cubic foot as the gas generally in use.

C. T. Konecny: For instance, burners used for natural gas or coke oven gas. Can you safely dilute it down to that range, for instance, 700 B.T.U. per cubic foot at that pressure?

W. H. Bateman: It would be safe to use a gas-air mixture of 700 B.T.U. per cubic foot.

H. V. Flagg: I may be stealing the gentleman's thunder, but this may answer the question: in one plant in the Chicago district they take still gas from the refinery, mix approximately two feet of air to each foot of gas and pipe the mixture through the entire plant without any trouble whatsover.

General Purpose Motors For Steel Mill Applications

By W. B. SNYDER,
Ind. Engr. Dept., General Electric Company, Schenectady, N. Y.

Presented before the Pittsburgh District Section of the A. I. & S. E. E. November 2, 1934.

This paper will be restricted to brief descriptions of several drives of particular interest, and will not attempt to cover such a broad subject in the limited time available.

Fig. 1 shows a sheet mill electric drag, furnished by the Freyn Engineering Company. It replaces the friction drag commonly used to take out the back lash in a sheet mill train. The advantages over the friction drag are:

1. The amount of drag can be readily adjusted, and when once adjusted, remains fairly constant.
2. The attention required is greatly reduced.
3. The energy absorbed by the drag is partly re

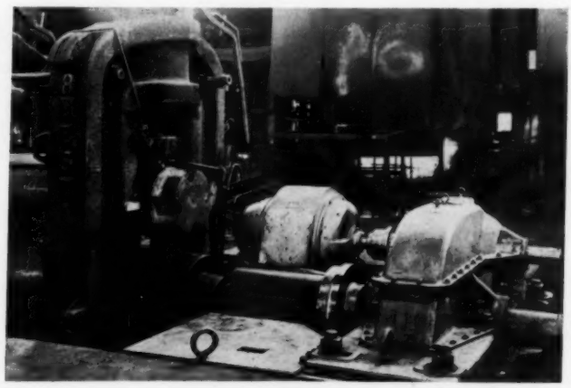

FIG. 1

turned to the power line, instead of being entirely wasted in heat.

This drag consists essentially of a 100 HP, 720 RPM, wound rotor induction motor with its stator connected to the power supply and with magnetic secondary control, quite similar to the conventional starting panel and resistor. The motor is connected to the lower roll of the last mill stand through a double reduction gear. The gear ratio is such that at the lowest operating speed of the mill, the induction machine is running far enough above synchronism to deliver full output as a generator.

The chief electrical problem on this installation was to maintain the output of the drag approximately

constant over the 10 or 15% change in speed present on induction motor-driven sheet mills. The secondary contactors in the drag generator circuit are controlled by current limit relays arranged so that when the mill speed increases and the output of the drag tends to rise, more resistance is inserted in the rotor circuit. Conversely, when the mill slows down, resistance is cut out of the rotor circuit. The load regulation requirements on the drag are not rigid, so no attempt is made to hold the drag generator output within limits closer than plus or minus 20 per cent of the predetermined value. However, this is many times more accurate than the regulation obtained on the usual friction drag.

Fig. 2 is a wire-drawing block driven by a DC adjustable speed gear-motor. It is of particular interest because of the compact arrangement of motor and control.

The motor is rated 20/40 HP—89/267 RPM output speed, with a gear ratio of 9:1. The motor drives

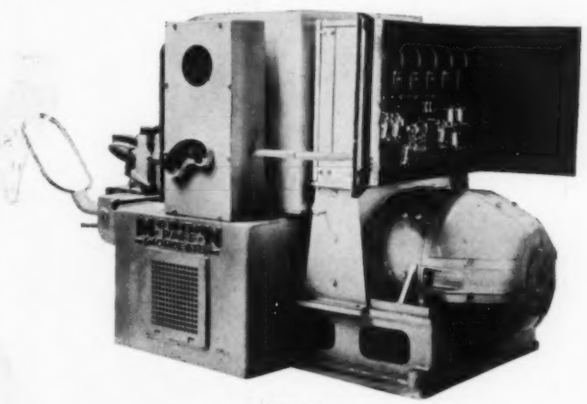

FIG. 2

the block through a bevel pinion overhung on the output shaft and meshing with a bevel gear on the block. To provide sufficient rigidity to the bevel gearing, the gear end of the motor is equipped with a mounting flange bolted to the frame of the block. The motor is provided with top solid-bottom perforated covers, both as a protection to the operator and to keep loose ends of the wire out of the machine.

The control panel is located in an enclosing cabinet over the gear end of the motor. The master switch and field rheostat are in the cabinet on the side of the block and the starting and dynamic braking resistor is located underneath the block in a compartment provided with screened ventilated openings. The control provides the usual features found on blocks of this type, that is, slow speed operation forward or reverse for spotting the block, two shunted armature points and three series resistance points for smooth acceleration, dynamic braking, and overload, undervoltage, field failure, and underload protection.

The advantages of such a drive from the point of view of small floor space and ease of installation are apparent.

Fig. 3 illustrates the application of a gear-motor of extremely high ratio to the chain drive of a tube drawing bench. The motor is a 30 HP, 1800 RPM normal torque low starting current, squirrel cage machine, and is overhung on the gear. The reduction ratio of the gear is 105:1, providing an output speed of 17 RPM at full load. This installation is an excellent example of how the desirable performance of a high speed

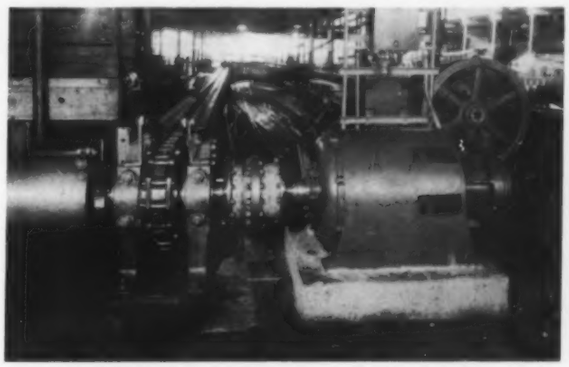

FIG. 3

motor, combined with compactness and ease of installation, can be obtained on low speed drives by the use of gear motors.

Fig. 4 shows a few of the 369 runout table motors driving the side runout tables of the Inland Steel Co's. 76 inch hot strip mill. These are totally enclosed, high resistance, squirrel cage ball bearing motors wound with Class B insulation and rated .25/2 HP, 225/900 RPM, 145/440 volt, 3 phase, 15/60 cycles. Power is supplied to these motors from four adjustable frequency sets, each set supplying one group. Each set consists of a 67.5/250 Kv-a alternator and two 37.5/-125 HP, 300/1200 RPM, direct current motors. Two motors are used on each set, rather than one, to reduce the WR^2 permitting more rapid acceleration and deceleration.

Each motor is used to drive two table rolls, a pinion mounted on the motor shaft being arranged to mesh with gears on the shafts of the rolls at either side of the motor.

This is an example of duty cycle drive on which the proper size and characteristics of the motors were determined by calculation. The WR^2 of the rolls and load, referred to the motor shaft is 25 lb. ft.^{2}, for each motor. The operating cycle is as follows:

FIG. 4

Accelerate from rest to full speed	— 4 seconds
Run at full speed	—10 seconds
Decelerate to rest	— 4 seconds
At rest	—12 seconds

Repeat indefinitely.

On these drives, it was found advisable, in order to reduce the size of the table motors, to cover most of the range of acceleration and deceleration by varying the voltage and frequency applied to the motor. Therefore, when the tables are started, the adjustable frequency set is running at 500 RPM, corresponding to

FIG. 5

25 cycles output frequency, and the motors are started from full voltage at this frequency. Then the adjustable frequency set is rapidly accelerated to top speed, carrying the motors along with it. During acceleration, the speed of the adjustable frequency set is first quickly reduced from top speed to 300 RPM, and then the motors are plugged to rest from 15 cycle power. By this type of control, most of the accelerating losses which would otherwise appear in the rotors of the table motors, are eliminated, resulting in smaller motors and less power consumption for the drive as a whole.

Another very interesting application is a drive for a coiler used on a hot strip mill. The mill was originally intended for rolling sheet mill break-downs and no coilers were provided. Instead, the strip issuing from the mill was delivered to a table about 200 feet long, and then the whole table was turned 90 degs. to discharge the strip at right angles to the line of the mill. Later, it was decided to install a coiler on one end of the turntable. The coiler was of the single drive type, requiring an adjustable speed direct current motor rated 75/150 HP, 40 deg., 300/1200 RPM, 230 volts. It was thought necessary to enclose the motor to protect it from water and mill scale, and, since forced ventilation from an external air supply would be extremely difficult, the purchaser requested a fan-cooled motor.

Fan-cooled motors have a wide field of application, but are subject (to a lesser extent) to the limitation of the surface-to-volume ratio which restricts the use of totally enclosed motors to small machines. In other words, the heat generated in a motor is roughly proportional to its volume and the heat dissipating capacity of an enclosed motor is proportional to its surface. Thus, the larger the motor is, the lower is the surface-volume ratio and the more difficult it becomes to get rid of the heat.

The motor required for this coiler was too large for economical fan cooling, so an enclosed self-ventilated motor was offered. Fig. 5 shows a motor of this type. It is a totally enclosed machine with an air intake opening over the commutator, and with an internal fan on the coupling end which draws air through the motor and discharges it from the volute housing on the coupling end. Such motors have sufficient fan action to overcome a reasonable duct drop, and in this case, it was found that the motor, even though it operated over a 4:1 speed range, would be capable of drawing all the cooling air necessary through an air filter having a ½" pressure drop. The recommended motor and air filter were purchased, and the success of the application was indicated by a repeat order received several months after the first machine was installed.

Fig. 6 illustrates one of the most severe general purpose motor applications of which we have any knowledge. The machine is a Putnam billet gouger for removing seams in large billets. It is equipped with a gouging tool which can be raised or lowered and moved back or forth over the face of the billets. In operation, a billet is forced through the machine by a hydraulic cylinder. The operator, by means of master switches controlling each tool motion, digs out seams or cracks as they pass under the tool head.

Each motion of the tool head is driven by a perfectly standard 7½ HP—40 deg. open-1150 RPM—230 volt- compound wound direct current motor with reversing magnetic control. In order to make the operation fast enough to permit the tool to follow irregular seams, the motors are started and reversed at

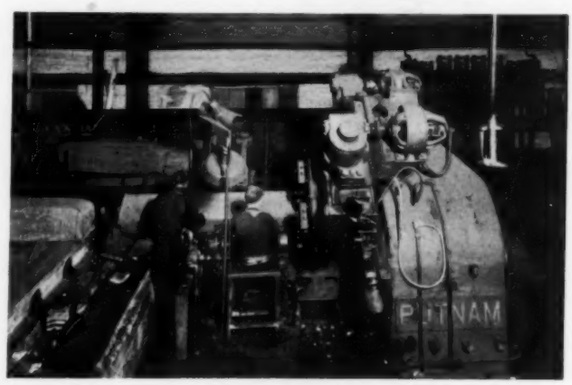

FIG. 6

practically full voltage. A small amount of resistance is left permanently in the circuit of each motor. These motors are called upon to reverse at the rate of 20 or 30 times a minute almost continuously for 16 hours a day, and the first machines have been in service about 4 years without a major repair. This drive is an outstanding example of the ability of the general purpose motor to stand up and take it.

It is hoped that these few applications will give a representative cross section of the wide field of use of the general purpose motor in steel mill service.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS SPRING ENGINEERING CONFERENCE

You are cordially invited to attend the A. I. & S. E. E. Annual Spring Engineering Conference to be held under the auspices of the Combustion Engineering Division at Ohio Hotel, Youngstown, O.

April 24-25, 1935

MR. HENRY ROEMER, President, Sharon Steel Hoop Company, Sharon, Pa., extends a cordial welcome to the membership of the A. I. & S. E. E. upon the occasion of their Annual Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

SHARON STEEL HOOP COMPANY

SHARON, PENNSYLVANIA

OFFICE OF THE PRESIDENT

March 9, 1935.

Association of Iron & Steel Electrical Engineers,
1010 Empire Building,
Pittsburgh,
Pennsylvania.

Gentlemen:

It is with a great deal of pleasure that I accept this opportunity of extending to the membership of the Association of Iron and Steel Electrical Engineers a most cordial welcome to Youngstown.

As one of the producers of steel in the Mahoning and Shenango valleys, we are indeed happy to learn that you have chosen Youngstown as the place for holding your annual Spring Engineering Conference. The city of Youngstown and the valley district generally, embracing as it does a great manufacturing territory, including steel plants on the Mahoning from Lowellville to Newton Falls, and many producing companies located on the Shenango from New Castle to Sharon - certainly must feel honored that you have decided to come here for this important meeting.

This district is rich in the romance of iron and steel; many of the characters who have developed this great industry have been figures of National and even International importance. Such men as Butler, Campbell, Wick, Todd, Stambaugh, Bentley, Andrews, Arms, and many, many others have lent color to the dramatic expansion of steel production in this territory. Many of these leaders have ranked with Carnegie, Frick, Gary, Schwab and other great builders of steel. It seems fitting that this meeting of steel mill engineers should be conducted here at Youngstown, where such a record of achievement has been established by those leaders of the past. Certainly the record and reputation built up by the pioneers in the iron and steel development of the valley is something worthy of the emulation of the younger generation.

It is with a feeling of honor and sincere appreciation for what you men have done to aid in this great development that we bid you welcome.

Respectfully yours,

Henry Rosemond

OFFICIAL PROGRAM

SPRING ENGINEERING CONFERENCE

AUSPICES OF

COMBUSTION ENGINEERING DIVISION
ASSOCIATION OF IRON & STEEL ELECTRICAL ENGINEERS

WEDNESDAY EVENING, APRIL 24
BALL ROOM, OHIO HOTEL

THURSDAY (all day), APRIL 25
YOUNGSTOWN, OHIO.

WEDNESDAY EVENING, APRIL 24

7:30 P. M.

Chairman
G. S. WARREN, Chief Engineer,
Sharon Steel Hoop Co.,
Sharon, Pa.

Secretary
C. J. DUBY, Chief Engineer,
Republic Steel Corporation,
Warren, Ohio.

"MAINTENANCE OF ROLL NECK BEARINGS"

by

H. D. ROBB, District Manager, Industrial Division, Timken Roller Bearing Company, Pittsburgh, Pa.
JOHN HITCHCOCK, Engineer, Morgan Construction Company, Worcester, Mass.
G. PALMGREN, Chief Engineer, SKF Industries, Inc., Philadelphia, Pa.
S. M. KEENER, Engineer, Salem Engineering Company, Salem, Ohio.
A. H. FRAUENTHAL, Engineer, Bantam Ball Bearing Company, South Bend, Ind.

THURSDAY MORNING, APRIL 25

9:30 A. M.

Chairman
F. W. CRAMER,
Superintendent of Electrical Construction,
Republic Steel Corporation,
Youngstown, Ohio.

Secretary
T. B. McELRAY, Supt.,
Light and Power,
Carnegie Steel Company,
Youngstown, Ohio.

"SELECTION OF ELECTRICAL EQUIPMENT FOR DIRECT CURRENT POWER SUPPLY IN ROLLING MILLS" by C. LYNN, Design Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

10:30 A. M.

Chairman
C. H. WILLIAMS, Steam Engineer,
Carnegie Steel Company,
Youngstown, Ohio.

Secretary
JOHN LEHNERT, Comb. Engr.,
Republic Steel Corp.,
Canton, Ohio.

"METALLURGICAL AND THERMO-DYNAMIC CALCULATIONS AS APPLIED TO HEATING FURNACES" by Walter de Fries, Combustion Engineer, McKeesport, Pa.

11:30 A. M.

Chairman
T. J. ESS, Combustion Engineer,
Republic Steel Corp.,
Massillon, Ohio.

Secretary
STANLEY McKEE,
Consulting Engineer,
Youngstown, Ohio.

"SOAKING PITS" by G. R. McDERMOTT, Vice Pres., Surface Combustion Corporation, Toledo, Ohio.

LUNCHEON 12:30 P. M. OHIO HOTEL

THURSDAY AFTERNOON, APRIL 25

1:30 P. M.

Chairman
F. E. FLYNN, Asst. Dist. Mgr.,
Republic Steel Corporation,
Warren, Ohio.

Secretary
J. H. VOHR, Supt. Hot Strip Mill,
Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

"MODERN ROLLING OF BROAD STRIP STEEL" by C. A. KRAL, Asst. Gen. Mgr., Wheeling Steel Corporation, Steubenville, Ohio.

2:15 P. M.

Chairman
F. C. SWARTZ, Open Hearth Supt.,
Carnegie Steel Company,
Youngstown, Ohio.

Secretary
C. C. WALES, Chief Engineer,
Otis Steel Company,
Cleveland, Ohio.

"DEVELOPMENTS IN DESIGN AND OPERATION OF OPEN HEARTH FURNACES" by R. S. BOWER, Open Hearth Supt., Corrigan-McKinney Steel Company, Cleveland, Ohio.

3:30 P. M.

Chairman
W. J. HARPER, Combustion Engineer,
Republic Steel Corporation,
Youngstown, Ohio.

Secretary
H. V. FLAGG, Comb. Engr.,
American Rolling Mill Co.,
Middletown, Ohio.

"NATURAL GAS IN STEEL PLANTS" by KARL EMMERLING, Asst. Gen. Supt., East Ohio Gas Co., Cleveland, Ohio.

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GENERAL SECRETARY
F. E. LEAHY, Fuel Engineer,
Youngstown Sheet and Tube Company,
Youngstown, Ohio.

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R. J. WYSOR, Vice President,
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Youngstown, Ohio.

J. M. HUGHES, Vice President,
Sharon Steel Hoop Company,
Sharon, Pa .

SECRETARY
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Weirton Steel Company,
Weirton, W. Va.

L. N. McDonald, General Superintendent, Youngstown District,
Carnegie Steel Company,
Youngstown, Ohio.

WILLIAM H. RAMAGE, President,
Valley Mould and Iron Company,
Hubbard, Ohio.

WILLIAM H. WARREN, General Manager,
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Steubenville, Ohio.

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Youngstown, Ohio.

SECRETARY
L. R. RANKIN, Electrical Superintendent,
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C. W. PHILLIPS, General Master Mechanic,
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ROBERT BACKUS, Gen. M. M.,
Carnegie Steel Company,
Youngstown, Ohio.

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Youngstown, Ohio.

O. R. JONES, Electrical Superintendent,
Sharon Steel Hoop Company,
Lowellville, Ohio.

LEONARD LARSEN, Manager of Steel Works,
Republic Steel Corporation,
Massillon, Ohio.

SECRETARY
J. D. DONOVAN, Mechanical and Electrical Superintendent,
Republic Steel Corporation,
Massillon, Ohio.

G. A. HUGHES, Electrical Engineer,
Truscon Steel Company,
Youngstown, Ohio.

J. B. MORGAN, Electrical Superintendent,
William B. Pollock Company,
Youngstown, Ohio.

HUGH B. CONOVER,
Asst. General Supt., Carnegie Steel Co.,
Mingo Junction, Ohio.

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Republic Steel Corporation,
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C. M. MYERS, Assistant Electrical Superintendent,
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Youngstown, Ohio.

F. J. THOMAS, Lubrication Engineer,
Republic Steel Corporation,
Youngstown, Ohio.

SECRETARY
STANLEY GRAND GIRARD, Electrical and Mechanical Superintendent,
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Sharon, Pa.

G. N. HARMON, Electrical Superintendent,
Republic Steel Corporation,
Warren, Ohio.

JOHN GILLESPIE, Assistant Superintendent Light and Power,
Carnegie Steel Company,
Youngstown, Ohio.

J. H. KREHL, Superintendent, Mechanical Department,
Youngstown Sheet and Tube Company,
Youngstown, Ohio.

HEREWITH ON THIS PAGE AND ELSEWHERE IN THIS ISSUE IS PRESENTED MANY PROMINENT STEEL MILL OFFICIALS WHO WILL PARTICIPATE IN VARIOUS FUNCTIONS OF THE SPRING ENGINEERING CONFERENCE.

W. H. BURR
Electrical and Mechanical Supt., Lukens Steel Company, Coatesville, Pa.

J. L. MILLER
Asst. Chief Engineer, Carnegie Steel Company, Youngstown, Ohio

F. E. LEAHY
Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio

L. N. McDONALD
General Superintendent, Carnegie Steel Company,
Youngstown District, Youngstown, Ohio

J. H. VOHR
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FRANK PURNELL

WHAT THE A. I. & S. E. E. SPRING CONFERENCE MEANS TO THE STEEL INDUSTRY

By FRANK PURNELL,
President, The Youngstown Sheet and Tube Company

The spring meeting of the Association of Iron and Steel Electrical Engineers, which will be held in Youngstown on April 24th and 25th, constitutes one of the industry's important annual events.

Our engineers face the problem of keeping production efficiency at a pace with new markets and new uses of steel.

Due largely to research progress made during the past few years, the industry is in a better position than ever before to meet the various complex demands of the future and to develop tomorrow's enormous potential markets.

New and better steels, especially adapted to the purposes for which they are to be used, are rendering obsolete a great deal of the country's present machinery and equipment. Eventually this must give rise to large programs of plant rehabilitation and replacement, and a revival of the demand for steel for durable goods.

Steel today is being used for countless purposes not dreamed of a few years ago. Dozens of household devices are made of steel which formerly were made of other materials. Steel is entering the housing field. Steel is supplanting wood in golf clubs, fishing tackle, and a host of other articles. A constantly higher percentage of steel is being used in automobiles.

In an infinite variety of ways the inventive minds within the industry are devising ways and means whereby steel can replace other materials, broaden markets, and increase tonnage.

Upon engineering skill rests largely the responsibility of translating the findings of the metallurgist into commercial production, with constant progress toward higher standards of operation which will keep costs at a minimum and quality at a maximum.

Out of this year's conference of the Association may be developed ideas which in the next few years will change substantially present practice with respect to various processes or products.

We in the industry welcome you to this great steel center. We believe that you will find the spring conference this year one of the most interesting and profitable in the history of the Association.

MODERN ROLLING OF BROAD STRIP STEEL

By C. A. KRAL,
Asst. Gen. Mgr., Wheeling Steel Corporation,
Steubenville, Ohio.

Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

New developments in the stamping industry have created mass production in the automobile and other industries. This brings to the steel maker the difficult task of meeting new and exacting requirements daily. In order to meet the demand for quality, it was necessary for the hot and cold strip mills to develop maximum drawing properties, accurate gauge and perfection of surface.

No doubt, this subject of "Modern Rolling of Broad Hot Strip" carries a wide range of thoughts among us all.

Its value depends upon the successful performance in the customer's plant, and at the same time making it profitable for the steel maker.

Regardless of good heating, rolling, finishing and heat treatment, the performance is not always successful. The quality of steel and its cleanliness is of primary importance, and this is dependent upon many factors, such as quality of iron and scrap, raw materials, working of the heat, deoxidation practice, temperature and slag control, mold size and surface, rimming action, etc.

Proper soaking pit practice is imperative to good quality. The ingots may be injured by over-heating, under-heating, uneven heating or worse than all, burning. An old pit saying: "An ingot is only ready to roll once" holds true in the majority of cases. Occasionally complications of schedules, changes by customers, grouped heats from the Open Hearth and other unforeseen difficulties prevent the ingot being rolled when ready. These penalties necessitate an ingot having sufficient factor of safety as to "skin" and above all, alertness, skill and ingenuity on the part of the heater to prevent the injuries mentioned above. In their hands rests a major part of the responsibilities of good surface on the strip.

Proper ingot structure and surface, good heating at pits, proper drafting on the bloomer yields a slab so reasonably free of defects that chipping is eliminated and permits rolling of high grade surface requirements hot through the furnace or direct to the strip mill without additional heating.

C. A. KRAL,
Asst. Gen. Mgr, Wheeling Steel Corporation,
Steubenville, Ohio

Too much stress cannot be placed on proper slab heating. The requirements here are uniform heating and a scale that is readily removed. The hazards of non-uniform heating are distorted and scabby surface, roll spoilage, camber, off gauge, cobbles and poor grain structure.

In obtaining the required surface, gauge and drawing qualities on the strip mill, many factors contribute to successful performance—among these factors are the quality of rolls and their temperatures both in roughing and finishing train, drafts, amount of hydraulic pressure and water applied per square inch of strip area, speeds on roughing and finishing stands, the thickness and temperature of strip at point of removing secondary scale, finishing temperature, distance of coilers from mill, temperature of coiling or piling.

The more recent mills and those to follow will be designed to over-come or minimize the mechanical handicaps of the earlier installations.

NATURAL GAS IN STEEL PLANTS

By K. EMMERLING,
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Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

The use of natural gas in steel plants is not new. Twenty-five years ago the percentage of fuel that was natural gas was probably as high as it is now. Between 1915 and 1920 the supply diminished rapidly, and to a great extent the use of gas in steel plants was discontinued. In recent years, deeper drilling and improved geological study have resulted in a great increase in the amount of natural gas available for steel plant use.

Every great steel making center has an adequate supply of naturaly gas available at reasonable prices, and its use in steel plants is increasing by leaps and bounds.

The use of natural gas in open hearth furnaces is becoming more common and if certain basic principles are followed no great difficulties in producing steel with 4—4½ million BTU per ton should be encountered.

In soaking pits natural gas is being used successfully in competition with producer gas, notwithstanding the fact that the cost of producer gas per million BTU is general lower than natural gas. Changeover from producer gas to natural gas is simple.

Where natural gas has made its greatest strides in steel plants is in the heating of steel in continuous furnaces. The introduction of semi-diffusion or luminous flame combustion, good automatic control equipment, and recognition of the value of natural gas in producing quality products has resulted in a widespread increase in use of and interest in the use of natural gas for this purpose. In wide strip mills, natural gas should be of particular advantage, due to its controllability.

In sheet mills the use of natural gas for pack and pair heating and normalizing has been accepted for a number of years. Recent developments in annealing of flat rolled steel by means of radiant tube and tube type annealing covers make natural gas particularly valuable for this purpose, and should change the picture in the annealing of sheet and strip entirely in the next few years.

Prepared atmospheres for bright annealing, deoxidizing, and the prevention of decarburization are most easily made from natural gas, and are coming into common use, particularly in sheet and strip annealing. One steel plant has reduced its cost of gas for deoxidizing to about two cents per ton. The use of special atmospheres prepared from natural gas has many possibilities, and much more widespread use will, no doubt, be made of them in the future.

From the writer's point of view, of course, the ideal steel plant would be one where natural gas is the only metallurgical fuel used. This, in most cases, is not to be attained, on account of the necessity of using up the coke oven gas produced in most steel plants. The most practical way of reducing the fuel problem in the steel plant, when natural gas in available, is by changing the entire plant over to a high heat value mixed gas, made up of coke oven, blast furnace, and natural gas.

Where the substitution of mixed gas is carried to completion, the problems incident to fuels should be reduced to a minimum.

METALLURGICAL AND THERMODYNAMIC CALCULATIONS AS APPLIED TO HEATING FURNACES

By WALTER de FRIES,
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Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

WALTER de FRIES

The paper to be presented on the subject of "Metallurgical and Thermodynamic Calculations as applied to Heating Furnaces", outlines a procedure for theoretical determination of all factors entering into the design of heating furnaces, expected to handle a definite tonnage in a given time and to a fixed temperature throughout.

It will deal, therefore, consecutively with the various factors governing the furnace performance itemized as follows:

Determination of hearth area and travel of material thereover, process heat requirements, relation of fuel application to size of preheating, heating and soaking zone, heating time determination on basis of temperature gradient and heat transfer rate penetration, fuel consumption as composed of furnace holding requirements, heat losses due to door openings, cooling appliances, and necessary process heat, required heat input for preheating, heating and soaking zone. Effect of recuperation and required changes in zone determination therewith; change in fuel consumption resulting therefrom; standby losses and conclusions; alternate fuels.

The foregoing data comprise the group identified as metallurgical calculations, which may and should be evaluated prior to any definite design conception of the furnace layout; their purpose is to create a mental picture of requirements which may then be interpreted through embodiment into a structure in such a way as to meet each and every one of them in the most simple and direct form of application. After that is accomplished it becomes necessary to analyze the proposed structure for desired performance through thermodynamic calculations, which govern the detail-design of all passages for fuel-gas and combustion air, each treated as individual circuits, and that for the waste gas movement through the furnace, the recuperator and the stack likewise divided into three separate circuits; the purpose of these calculations is the determination of energy requirements for the movement of heat supplying gases through the furnace system as inherently available through buoyancy governed by the furnace and stack design or as separately provided for from external sources.

These thermodynamic calculations are of at least equal importance to the metallurgical predeterminations, because on their correct evaluation depends the furnace performance; they furnish reliable figures for the determination of optimum passages for all cir--

cuits assuring adequate supply of fuel and combustion air as well as unimpeded movement of waste gases at velocities most appropriate for heat transfer.

Inasmuch as the methods of calculation herein discussed, while known for some time, have seldom been discussed in their relation to actual practice, it is expected that such outline of a definite procedure will stimulate a critical discussion of the subject-matter, through which furnace performance may ultimately be accurately predetermined and assured.

THE DEVELOPMENTS IN DESIGN AND OPERATION OF OPEN HEARTH FURNACES

By R. S. BOWER,
Open Hearth Supt., Corrigan-McKinney Steel Company, Cleveland, Ohio.

Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

R. S. BOWER

The melting of steel in regenerative open hearth furnaces was first proposed by C. W. Siemens under specifications of his British letter Patent A.D. 1861.

This fundamental patent, as used with producer gas for heating is shown in Fig. 1. The furnace consists essentially of the melting hearth, a, and the regenerators, composed of a pair of chambers, bb, for gas, and a further pair of chambers, cc, for air. All chambers are filled with a checker work of firebrick. The gas from producer main A enters the furnace through valve d to chamber b, ascends into the right hand side and above the hearth, where it is mixed with the air, introduced through B and valve E to chamber C and ignited. The flame produced pass over the hearth A, transmitting part of its heat to the material to be melted on the hearth. The waste gases pass into the chambers b and c, giving heat to the checker brick as they descend and finally through valve D and C to the stack C. When the checkers have reached their thermal saturation, the

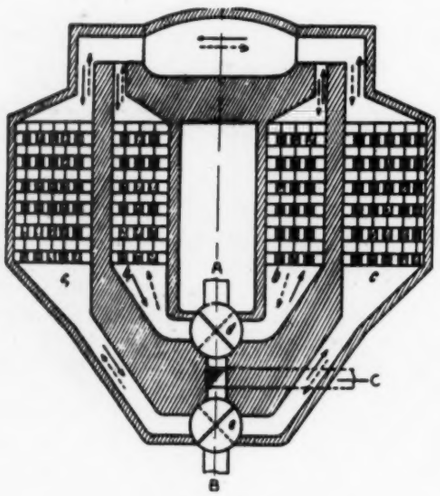

FIG. 1

valves D and C are set in position shown by broken lines so that the current of air, gas and waste gas is reversed as shown by broken line arrows. The incoming air and gas now take up the heat stored in the chambers and enter the hearth at higher temperature. The waste gases give their heat to the outgoing checkers. Thus with periodically reversing valves, alternate heat change and discharge of the chambers take place.

For the past seventy-four years this regenerative principle has not changed and it is my belief that the regenerative or open hearth furnace will make the larger portion of our steel requirements for a good many years to come. Details of construction design and operations have changed as the furnaces have increased in size from two tons to three hundred tons or more.

In this paper which I have been asked to present before your aggressive Association, I will try and show the development of the constantly changing details, any one of which could be made a subject that would take up the entire time allotted for this paper. The following is an outline that will be followed:

Brief outline of the early history of the open hearth furnace.

The general development of furnace construction from the original two ton furnace built in 1864 to the large furnaces of today.

Fuels:

A—Producer Gas. Old and new producers.
B—Coke gas fired furnaces.
C—Oil fired furnaces. The use of super
D—Coke gas and Tar fired. heated steam for
E—Tar fired. atomizing.

Furnace Meters:
A—Gas flow meters.
B—Liquid flow meters.
C—Pressure and Vacuum gauges.
Valve Construction:
A—Old type.
B—Slide type. Water cooled and dry dampers.
Insulation:
A—Methods employed.
B—Probable results.
Furnace Automatic Control:
A—Pressure.
B—Combustion control.
1. Fuel—Air ratios.
2. Waste gases analysis.
C—Reversal control.
D—Types.
1. Electric.
2. Air.
3. Hydraulic.
4. The Isley Furnace.

The Trend in Checker Design:
A—Types.
B—Cleaning checkers.

A Brief Look Into the Future:
Multiple burner furnaces.
Charging a furnace in one minute.

INFLUENCE OF NECK DEFLECTION ON LIFE OF ANTI-FRICTION BEARINGS

By A. H. FRAUENTHAL,
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Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

The limiting factor in roll neck bearing life and the major cause of roll neck bearing failure is the poor load distribution over the length of the bearing which occurs when the roll neck deflects.

Roll neck deflection causes concentration of the load on a small portion of the bearing. As a result of failure to compensate for this condition, it has been necessary continually to increase the size of roll neck bearings until the capacity of the bearings has become so great that a small portion of the bearing is capable of carrying the load.

This results in larger roll diameters and increase of other mill parts in porportion until it now seems that each succeeding mill is larger than the last built for the same general purpose. Consequently roll diameters have already reached the point where their production in the foundry is a major problem.

It seems clear that if roll neck bearings can be arranged so the entire bearing instead of only a small portion is operative, much smaller bearings can be used to give satisfactory life. Likewise life will become extremely long with the large size bearings in use on the most modern mills.

An examination of bearings that have been in service on bottom rolls shows that the greater portion of the rolling load has been carried on a short length of the bearing. This short length is located toward the inside of the mill and is the portion of the bearing nearest the roll barrel.

The reason for this is the angular position of the roll neck caused by the deflection of the roll body and the roll neck under load.

This condition is now so universally recognized that various devices have been tried to provide some means for self-alignment of the chock to bring the angle of the bearing coincident with the angle of the neck.

These several designs used, while differing in detail, fall into one of three classes.

Class 1 uses a male and female spherical seat requiring relative sliding of the seats to permit chock movement. This movement never takes place due to the extremely high friction. Any attempt to lubricate these surfaces fails because of lack of the fundamental requirements for formation of film.

Class 2 is a virtual knife edge on the bottom of the chock contacting with a plane surface on the bottom of the housing.

A. H. FRAUENTHAL

Class 3 is a roller segment on the bottom of the chock contacting with a plane surface on the housing.

An analysis of these last two devices shows that for the chock to rock on the knife edge or roller segment it would be necessary for the roll to shorten. As this is impossible no rocking action can take place.

To obtain self-alignment of the chock it is necessary for the bottom of the chock to move outward by sliding on the housing under load. Again it is obvious that friction is too high for any such sliding

to take place and an inspection of many mills of this design fails to disclose any indication of sliding.

It should be brought out here that certain calculations seem to indicate that sliding will take place. These figures as well as the action of the various types of self-aligning devices are analyzed and illustrated in the complete paper.

A question arises here because experience has shown that when a knife edge or similar device is used on chocks improved bearing life is obtained. The question is—why if the chock does not self-align is the bearing life improved?

With such a device the inner edge of the chock which normally receives the greatest amount of load is not supported by the housing and for this reason can deform elastically.

This deformation or "moving away from the load" permits more of the load to be carried by portions of the bearing farther away from the inner edge of the chock and thus increases the load carrying length of the bearing.

This explains why in some cases better bearing life is obtained in old mills where the chock is rather thin on the load side than in more modern mills having very thick chocks on the load side.

Another method of construction for heavy mills is that of two self-aligning bearings mounted on the same neck. To obtain self-alignment of the chock it is necessary for the outer races to move endwise against static friction under load.

For a chock to self-align with present designs it would be necessary in every case to overcome static friction under the mill load. In every case the friction load is far too high to be transmitted through the elastic materials involved without failure of these materials.

For a bottom chock to actually self-align it is necessary for the bottom of the chock to move outward and this can only be accomplished by anti-friction means.

An anti-friction device of this type is the Bantam roller aligner consisting of a single roller located between hardened plates on the center line of the bearing transverse to the axes of the rolls.

A model to demonstrate the poor distribution of load with the conventional mounting and the correction of this condition by use of the Bantam roller aligner is available. This model consists of two small replicas of roller bearing chocks with knife edge load side in which the roller bearings have been replaced by rubber plugs.

When the roll is deflected the chock does not rock and the inside end of the rubber plug is severely deflected.

Inserting a roller under the chock permits the chock to rock and relieves the deflection on the end of the rubber by carrying the load over its entire length.

This device as now in use consists of three major parts.

A hardened steel plate is fastened in a groove in the chock by means of a small clamp.

Another identical plate rests on the bottom of the housing window.

Between these plates is a roller divided into convenient lengths.

The rollers are held in a cast bronze cage, the cage and roller assembly being located by springs that hold it central while changing rolls.

The spring mounting permits the roller to move a sufficient distance in both directions.

With this construction the chock can tilt angularly by means of the anti-friction motion of the roller and thus distribute the load over the entire length of the bearing.

A secondary advantage of this mounting lies in its providing anti-friction surfaces to handle the motion incident to expansion and contraction.

Where this motion takes place through sliding friction the momentary thrust loads are very high. In some cases, especially with taper roller bearings this has contributed to short life.

While it is possible at this time to give only a preliminary report on the use of this device in regularly operating mills, enough data is at hand to indicate that all requirements are met.

Measurements of chock motion taken with dial indicators show that chocks equipped with the aligner self-align to an angle of ten thousandths of an inch (.010") per foot under very heavy load.

Similar measurements taken under identical conditions but without the aligner show absolute absence of any self-alignment.

With mills thus far studied it does not appear to be necessary to use this device on top rolls. The screw and surrounding parts of the mill have an inherent looseness and flexibility which permits the outward movement of the load side of the chock so that some self-alignment of the top bearings usually takes place with the conventional mounting.

It is of interest to note that steel mill records show there is very little trouble with bearings used continuously on top rolls as compared with bearings used continuously on bottom rolls.

It is clear from examination that this condition is due to the better load distribution obtained on top rolls as compared with that on bottom rolls with conventional mountings.

This condition has not been universally observed. It has sometimes been stated that on top rolls due to their position very little, if any, water or dirt gets into the bearings, whereas on the bottom bearings the water can run in by gravity and the majority of it will get into the bearing on the inside end.

An examination of bearings operated on both bottom and top rolls under many different conditions and on many different mills indicates the fallacy of this theory. It is quite clear that the damage to the bearings is done by load and not by corrosion and dirt. The difference in appearance is very clear to those familiar with such details.

Consolidating present experience we come to the following conclusions:

1. Roll neck bearings fail mainly because of poor load distribution.

2. Many top roll mountings are favorable because of their flexibility.

3. No past method of bottom roll mounting permits self-alignment due to friction conditions.

4. The Bantam roller aligner accomplishes self-alignment and good load distribution by its anti-friction character.

THE SELECTION OF ELECTRICAL EQUIPMENT FOR DIRECT CURRENT POWER SUPPLY IN ROLLING MILLS

By C. LYNN,
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Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held at Youngstown, Ohio, April 24 and 25, 1935.

C. LYNN

Practically all power supplies for continuous rolling mills consist of motor generator sets. Synchronous motors are preferred for driving the generators as they are cheaper, more efficient, and provide power factor control. Within ordinary limits they are unaffected by voltage variations. Larger capacity sets are usually of the three unit type, two duplicate generators being driven by one large a.c. motor. This permits higher operating speeds for a given output, with a corresponding reduction in space required and cost.

Experience over a considerable period of time indicates that the best overall operation results when the voltage of the generators is controlled by a voltage regulator. These generators may be either straight shunt or slightly differentially compound, separately excited in either case. The use of a slight differential series field produces better inherent division of load between the several generators in parallel, as well as eliminating the detrimental effect of heavy circulating currents at the minimum voltage.

Since practically all continuous mills are started from rest by bringing the generator voltage up from residual to rated voltage, the use of shunt or differentially compound wound generators permits all generators to be operated in parallel as a unit over this voltage range.

These generators are normally separately excited and can all be excited from one common exciter. The voltage regulator can, therefore, be applied to the fields of this one exciter. All generators will thus respond alike and maintain a practically constant voltage at whatever value desired.

The voltage regulation of any d.c. machine is influenced by the constancy of the supply frequency, the temperature changes of the generator, the permanency of the manufacturer's original test floor adjustments, and the fluctuations of the excitation supply voltage. The advantage of the voltage regulator control is apparent, since it can correct for variation in any of these factors and hold the voltage essentially constant even with load changes, irrespective of the inherent voltage regulation of the generators themselves.

The first application of continuous steel mill generators used straight flat compound wound machines. These machines gave fairly flat voltage regulation but good division of load could not be secured, especially if operation at other than rated voltage were attempted. By providing the generators with differential series fields as well as cumulative series fields and adjusting the fields for a predominance of the cumulative series field, approximately flat voltage regulation could be secured. To secure the maximum degree of load division, the cumulative series fields of two duplicate generators in parallel were crossed. No equalizer was necessary when paralleling with this scheme of connection. With any tendency of unequal load division, the differential series field would lower the voltage of the generator hogging the load and the crossed series field would raise the voltage of the generator shirking the load, thus providing stability and equalizing the load division. When more than two generators are operated in parallel, the cumulative series fields can be staggered or the machines operated in groups of two.

Modern motor generator sets are made of fabricated steel construction. The use of rolled steel instead of castings provides a more substantial construction with better magnetic characteristics. Compensating or pole face windings are used as they impose less duty on the voltage regulator and give superior commutation at high overload swings. Modern brush rigging with double brush holders and the developments made in commutator construction in the past few years assure improved commutation and uninterrupted service.

Synchronous converters are not satisfactory for continuous mill power supply since they cannot operate over the voltage range required nor do they give a sufficiently constant voltage regulation. They are, therefore, never used for such service.

A SELF-ALIGNING DEVICE FOR THE WORK ROLLS OF FOUR HIGH MILLS

By J. H. HITCHCOCK,
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Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24, 25, 1935.

A prerequisite to the successful operation of four-high mills is correct alignment of rolls. If either work roll is not parallel to its respective backing roll, rotation of the rolls under load produces a force which tends to move the work roll and backing roll endwise in opposite directions. Since the backing roll bearings are usually clamped more securely to the roll housings, the work roll in most cases is more likely to be moved. The magnitude of the axial force, determined by the vertical load and coefficient of friction between the rolls, as well as by the degree of misalignment, has been sufficient in numerous cases to rupture sturdy clamping devices and push a work roll completely out of the roll housing. It is conceivable, of course, that clamping dogs and bolts may be made strong enough to keep the rolls in place even with considerable misalignment, but in that event the forces resulting from misalignment produce unnecessary loads and dangerous stresses in the roll neck bearings. Consequently, misalignment of rolls is recognized as a very objectionable condition.

Positive alignment of rolls can be assured by use of the simple and ingenious device which is to be described. This self-aligning device is illustrated in Fig. 1, which represents a horizontal section through a four-high roll housing at the elevation of the pass line, looking down upon the lower work roll and its bearings. Each work roll bearing is mounted between parallel wedges, so arranged that axial movement of the roll changes the alignment of the roll axis. No restraint whatever is imposed upon the work roll bearings with respect to endwise movement, except that in moving they must follow the slightly diagonal paths established by the parallel wedges. The bearing casings are fitted at the sides with hardened steel plates having cylindrical outer surfaces. These cylindrical plates may be permitted to bear against the wedges themselves, in which case the wedges should be hardened; or auxiliary plates having cylindrical seats, as shown in Fig. 1, may be interposed to provide a wider surface of contact.

The operation of this self-aligning device is based upon the principle that the forces which result from misalignment can be used to align the rolls properly. From the foregoing statements it is evident that no appreciable axial force can be applied to the work roll without causing it to move endwise, carrying its bearings along between the parallel wedges. This endwise movement and the accompanying change of alignment, if the inclination of the parallel wedges is properly established, places the work roll in accurate alignment with its respective backing roll and eliminates the axial force which initiated the movement.

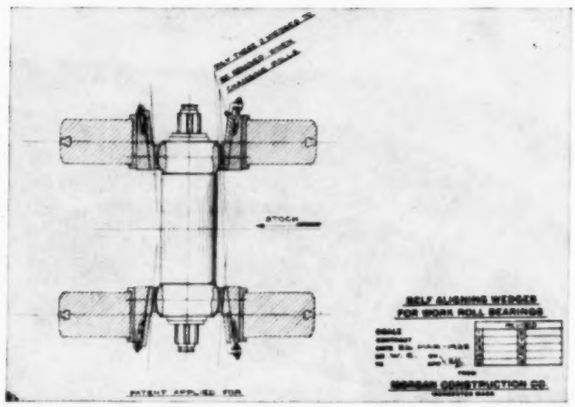

FIG. 1

It is pertinent to note that the parallel wedges constitute no handicap to the operation of changing rolls. Removal of the longer wedge on each side of the roll housing provides ample clearance for withdrawing the work roll with its bearings and installing a new roll and bearing assembly. The removed wedges can then be replaced at the same setting, as indicated by the inner nut on the clamping bolt, or if necessary they can be drawn in further to eliminate lost motion. The opposite wedge on each side of the roll housing can be left in place permanently.

The fact should be mentioned that this device is not applicable to four-high reversing mills, nor to the small middle rolls of three-high mills which roll in both directions. When the direction of rolling is reversed, the direction of the axial force due to misalignment is likewise reversed; so that the endwise movement of the work roll and its bearings, instead of correcting the misalignment, would accentuate it.

After conducting comprehensive experiments and applying for patent protection, the Morgan Construction Company last year placed this self-aligning device in active operation on a small four-high cold strip mill which is likewise equipped with Morgoil bearings. This unit has operated consistently in a most satisfactory manner, and has demonstrated in practice the advantages of positive roll alignment.

Another useful device which has been developed for use with our bearings on two-high mills is the adjustable bearing clamp. This device is designed to permit precision axial alignment of passes on mills rolling shapes. With our bearings all axial thrust loads in both directions are absorbed by a double acting thrust bearing built into the bearing on the working end of the roll, so that no clamps on the drive side of the housing are necessary. The clamping device is constructed with two pairs of jaws hinged to heavy brackets attached to the housing posts. The jaws of the upper pair act on the outer face of the ears on the bearing casing, while the lower jaws engage the inner face. The jaws of each pair are connected together by a heavy turnbuckle. Axial adjustment of the roll is readily made by slacking off on one turnbuckle and taking up on the other, or vice versa. Inasmuch as one turnbuckle is always in tension while the other is always in compression, all backlash in the hinge pins is eliminated and positive alignment can be maintained.

This type of clamping device affords several distinct advantages.

1—Due to its parallelogram construction, it is impossible for the roller to cramp the bearing in the housing window, as the bearing is always free to align itself correctly in spite of the fact that it is always rigidly held endwise.

2—Roll changes are made more readily than with the customary clamping dogs. The turnbuckles are slacked off only a sufficient amount to permit the removal of one hinge pin at the end of each turnbuckle. This frees the entire clamping device, which is then swung clear of the bearing casing.

3—The position of the turnbuckles in relation to the housing makes them freely accessible when making adjustments. In addition, only two applications of a wrench are necessary, as against at least four or more when making adjustments with the conventional type of clamping dogs.

SOAKING PITS

By G. R. McDERMOTT,
Vice President, Surface Combustion Corporation, Chapman-Stein Division, Toledo, Ohio.

Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24, 25, 1935.

At the June, 1930, Convention of this Association, held in Buffalo, we had the privilege of reading a paper covering developments in industrial furnace design as applied to the steel industry and we dwelt somewhat on the subject of soaking pits and the one-way-fired or refractory recuperative pit, in particular.

Since that time additional installations have been made—in some cases in the rebuilding of regenerative pits to the one-way-fired pit and also complete new installations. The fuels used have been general in their kind, such as coke-oven gas, producer gas, natural gas, refinery gas and fuel oil. The most recent installation is two-four batteries for one of the Eastern Plants where oil is the fuel in use.

It is perhaps permissible to review the fundamental principle of design of the one-way-fired pit, which has since been so universally accepted by the trade as a step forward in the economic and quality heating of ingots.

The firing ports of the one-way-fired pits are located in one of the end walls and the products of combustion or flame is developed in a combustion space immediately above the ingots to be heated. The ingots are usually arranged in two rows along the longitudinal axis of the pit, usually from two to four ingots per row, depending on the size of ingots charged.

The hot products of combustion are delivered in part to the far wall of the pit where they turn downward between the ingots, reverse their direction and leave the pit through suitable waste gas outlets to the recuperator. Such a design permits the selection of a firing port suitable for the particular fuel to be used, thereby providing for maximum combustion efficiency.

The intensity of draft imposed on each hole of the battery is controlled by a suitable damper installed immediately after each recuperator of each hole of the battery. The operator thereby may regulate the rate of firing and also the distribution of products of combustion by the amount of draft imposed on the hole, i. e. the products of combustion assume a horizontal horseshoe path and the length of the horseshoe is controlled by the draft imposed.

G. R. McDERMOTT

In the case of the regenerative pit the firing port alternately becomes a combustion port and a waste gas port. Under such conditions the firing port then becomes a compromise from the standpoint of providing a port design for maximum combustion efficiency. Furthermore, since there exists this comprise of alternating waste gas and combustion port, it necessarily means that the waste gas port is located well below the top of the ingots with the result that when used as a firing port the flames of combustion impinge upon the ingot surfaces. It will then be readily appreciated by those familiar with the heating of ingots the extreme care which must be taken to prevent damage to the ingot surface by over heating. This is particularly true when thin skinned, high carbon and alloy steels are heated. When the combustion takes place above the steel, the possibility of burning the steel has been reduced to a minimum.

As mentioned before, one of the recent installations provides for fuel oil firing and it is on account of the principle of design that the application of fuel oil is a success as a soaking pit fuel. The use of fuel oil for regenerative or reversing pits has been rather limited, and then only in the case of emergency, on account of the harsh characteristic of the flame.

We have been giving considerable thought recently to automatic temperature control of ingot heating. It is true that pit operators from experi-

ence become quite proficient in their judgment of the proper ingot temperature for rolling. However, considering the narrow range of heating temperature requirements for different chemical analysis it would seem that reliance to the heater's eye without the constant use of pyrometric control has some hazards. To illustrate we give below a heating schedule in use at one of the prominent steel plants:

Carbon Range	Manganese	Temperature
.06— .12 to .50—1.20	25—60	2350°F 2175°F
.06— .15	Phos. .06—1.00	2375
.04— .06	" .04— .06	2350
.06— .15	Sulphur .06—1.00	2400
.06— .15	" .04— .06	2350
.35— .80	Silicon 1.00 and up Mang. .60 and up	2250
.06— .15	Silicon 1.00 and up	1900
Ingot iron		2400

We are at present constructing two batteries of soaking pits at the Campbell Works of the Youngstown Sheet and Tube Company and in connection with one of the holes we have installed pyrometric equipment for automatically controlling the firing of the hole. This apparatus together with its application will be described at the coming meeting.

MAINTENANCE OF ROLL NECK BEARINGS

By H. D. ROBB,
Pittsburgh District Manager, The Timken Roller Bearing Company.

Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24, 25, 1935.

H. D. ROBB

Maintenance of roll neck bearings is not exclusively a function of the mechanical department, but must also be considered by the engineering, operating, and executive departments.

The size of the bearing is closely related to its life, and the economic balance between life, cost, and maintenance must be decided by the management before the bearing is ordered. Planned procedure may, however, be wrecked by careless or reckless operation in an endeavor to crowd production. Rolling under pressure control rather than gauge reduction alone is recommended. Doubling the bearing load decreases the bearing life to one-tenth the normal expectancy, while reducing the bearing load to one-half increases the life ten times.

On the first indication of bearing trouble the bearing should be removed for examination. Immediate attention usually enables a simple repair to be made, such as replacing a roll or touching up a spalled spot. Waiting for the turn or until roll grinding is required may completely wreck the bearing. The maintenance department should be authorized to issue instructions that a damaged bearing be removed from a roll neck before it is a complete wreck.

Care should be exercised to see that wedges are so assembled that the chocks on the floating side are free to find their own centers, and it is suggested that chocks be built so as to follow the deflection of the rolls, experience showing that the flat on the bottom should give from 15,000 to 20,000 pounds per square inch and that the bottom of the chock be beveled on a taper to 1/16 inch at the end of the chock.

Spare bearings should be purchased. Some should be mounted at once to facilitate roll changes. Those not mounted should be stored in a clean, dry room not subject to acid fumes. Care should be exercised in handling bearings, as they are precision products.

Proper lubrication is essential and The Timken Roller Bearing Company has pioneered in the cooperative development of E. P. lubricants. On one installation trouble occurred at first, but cleared up when the lubricant was changed to an E. P. type, and last reports indicate that approximately 1,000,000 tons of steel have been rolled on the bearings.

Periodic bearing inspection is advisable, accomplishing the four-fold purpose of:

1. Removal of contaminated lubricant.
2. Replacement of fatigued rolls and the shifting of maximum load area by rotating the outer races 90° when replacing them.
3. Adjusting for wear, an average maximum clearance of .001" between rolls and races being recommended.
4. Reduction of roll neck scoring, an instance being cited where a six months period showed a wear of .006", but a nine month period showed .015" wear.

Accurate records of bearing tonnage should be maintained, and a chart form is suggested and outlined.

REJUVENATING TANK FOR ROLL NECK BEARINGS

By S. F. KEENER,
Salem Engineering Company,
Salem, Ohio.

Abstract of paper to be presented at the A. I. & S. E. E. Spring Engineering Conference, to be held in Youngstown, Ohio, April 24, 25, 1935.

S. F. KEENER

This paper will be presented at the Spring Engineering Conference April 24 and 25, as a supplement to the paper, "Maintenance of Roll Neck Bearings" by Mr. Harry Robb of The Timken Roller Bearing Company.

Spurred by the increasing use of roller bearings in rolling mills and the increasing size and initial cost of these bearings, a considerable metallurgical research has been carried out which has developed the fact that the life of these bearings can be somewhat prolonged by a low temperature heat treatment at regular intervals.

Briefly, this treatment consists in heating the bearing to between 325 and 350° F. and holding at temperature for two hours per inch of maximum cross-section of the bearing. The interval between treatments is from three to six months.

The type of equipment selected to most satisfactorily meet these conditions, in this particular case was an electrically heated oil bath. Factors which influenced this selection include the low temperatures involved, the somewhat bulky nature of the piece to be heated, the rapid and uniform heat transfer with a liquid heating medium, and the necessity for low first cost of equipment to be used only occasionally. Such a furnace was installed by the Timken Roller Bearing Company for this purpose, and it has clearly demonstrated the wisdom of this choice from the standpoint of both performance and economy.

Numerous problems are involved in the successful design of such equipment. The oil found to be most satisfactory as a heating medium has the specifications:

Neutral paraffin base 28-29° Be.
Viscosity 100 seconds at 100° F.
Flash point 375° F., and
Fire point 425° F.

In order to insure uniform temperature on all parts of the bearing, a circulation of the oil is essential, which is accomplished by a motor driven fan in conjunction with baffles to direct the oil circulation upward past the heating elements and down through the heating material. The flow of the oil must be uniform through all parts of the cross section of the heating chamber. Too vigorous an agitation of the oil by the propeller will cause carbon deposition, which is almost entirely avoided by proper propellor speed.

The arrangement of the electric heating elements is around the outside walls of the pit, and the mounting is a removable frame to permit ready access to all parts of the elements and chamber for repairs or cleaning.

The binding of the furnace consists of a double steel shell filled with insulating material. A removable cover of substantially the same construction is provided for access to the furnace when charging and discharging rolls. The rolls are supported on a heavy structural supporting rack in the bottom of the furnace.

The furnace is generally located in a pit in the floor, with the top projecting above the floor to a height convenient for loading.

The economy, or electric energy consumption of the rejuvenating furnace depends upon the rate of heating. The records for the initial furnace which was 66" dia. x 37" deep effective loading volume, indicate an average production of 1000 pounds of bearings heat treated per hour, with an energy consumption of 2.7 K.W.H. per 100 pounds, or 54 K.W.H. per ton. On the same furnace the best production recorded was 3000 pounds per hour, with an energy consumption of 1.1 K.W.H. per 100 pounds, or 22 K.W.H. per ton. The furnace can be heated from cold to 350° F. in 12 hours, and has a connected load of 25 KVA.

In conclusion, it may be said that the simple heating device outlined above, when properly designed, offers the best method so far developed for carrying out the metallurgical process of roll neck bearing rejuvenation, developed by The Timken Roller Bearing Company for prolonging the life of mill type roller bearings. The important result of the process utilizing this equipment is, of course, a reduction in the maintenance cost of rolling mill bearings.

ROLL NECK BEARINGS

By C. J. KLEIN
Chief Engineer, Weirton Steel Company,
Weirton, W. Va.

C. J. KLEIN

With the introduction of the four-high hot and cold mills came the extensive use of roller bearings, first on the backup rolls, then on the working rolls. At that time little was known in the way of pressures that these bearings would be called upon to carry, also installations that were made in the early days were so far ahead of the two-high friction type mill that specifications as to speed, gauge, etc., do not meet present day practice, with the result that these mills have had to undergo certain minor changes to increase bearing capacities.

In quite a few cases, it was found that neck diameters were large enough to permit a reduction, thereby adding to the bearing size. It has also been possible in many cases to increase the length of the bearings. Another possibility, where plant extensions are being made, is to use existing equipment for slightly narrower widths and install heavier mills for the greater widths. The foregoing refers to early installed mills only. At the present time there is sufficient data available to properly ascertain the size of bearing required.

However, with all the data that is at hand it is not possible to provide bearings absolutely free from trouble, but with reasonable handling and operating conditions, very little difficulty should be encountered. Having ascertained the width of material to be rolled, gauge of material entering and leaving the stand, and the speed of the material through the mill, as well as the various specifications of material to be rolled, a fair idea of the bearing size can be arrived at. There are two conditions which may determine the size of bearing, namely, possible overloading of same and life in operating hours due to fatigue of the metal. The size of the bearing plays a major part in the determination of the roll diameters and the rolls in turn set the width of the housing windows due to roll changing.

The design and construction of the bearing mounting is of vital importance for the continued and long life of the bearings. Provision must be made for roll neck deflection, which necessarily would cause concentration of the load on the bearing, if not properly mounted. Roll expansion both as to diameter and length must be taken into account in the bearing clearances as well as the clamping arrangement. The clamping arrangement of rolls which must be changed frequently must be of such a construction that no delay is encountered in the changing of same. Also, the roll changing rig must be such that crane attachments and lifts are at a minimum. The sealing of the bearing mounting at the roll neck has probably received more thought and study than any other part. Single, double and triple seals have been used and usually the more seals used, the greater the difficulty is in roll changing and maintaining same. However, it is quite important that the water with its foreign matter be kept out and the lubricant kept in, the mechanism required to maintain this condition being secondary. The next important feature in design is the method used in assembling and dismantling the roller bearings. With some designs it is necessary at times to destroy certain parts of the bearings due to same becoming tightly lodged on the roll neck or in the bearing housing. With the proper design this condition can be entirely eliminated. Roll mountings should preferably be of the fixed type, in other words, no wedges or other methods of adjustment should be required in the roll setup; this eliminates the possibility of crossing rolls once they are properly mounted. The machine shop work of roller bearing mountings should be of the best type possible, as it is quite important that all surfaces pertaining to the alignment of the rolls be accurate in order to eliminate the crossing of same with its resultant end thrust.

When rolling very light gauges, for instance, cold rolled tin plate, it is necessary to put the mill under a load without any steel going through the mill, and this is caused by the fact that there is a certain give in the setup when under load. It is quite possible for the roller to set the mill entirely too tight and still produce a properly rolled strip. This may cause an overload on the roller bearings as well as other parts of the mill. In order to provide the operator with information in this respect, various types of housing elongation devices, pressure indicators for installation under the housing screws, etc., have been used. These instruments can be of the indicating or recording type or both. Once the roller has found the minimum pressure under which certain specifications can be rolled, a record can be made of same and can then be duplicated. This method of operation should be of quite some value in the extended life of bearings due to the fact that the lightest load can be determined and then maintained.

The care of roller bearings can be taken care of to the best advantage if a separate department is set up for this purpose. Cleaning apparatus in the way of dipping tanks or pressure sprays will facilitate the thorough degreasing of the bearing for inspection. Systematic and periodic inspection of bearings is quite important as a small break or fracture

of any part of same, if not detected in time, may cause the complete destruction of same. If any foreign matter is found to be in the roller cage, same should be dismantled and thoroughly cleaned out before using. It is desirable to have the crane operator for handling bearing assemblies as close to the work as possible so that he can see the work, as considerable damage can be done to seals, etc., due to improper handling of same.

Lubrication manufacturers have developed quite a number of greases and oils suitable for the severe loading conditions imposed on this type of bearing. The method and cycle of lubricant application is quite important, in other words, it is preferable to apply same in consistent quantities and at fairly frequent intervals. The amount of lubricant to apply seems to vary to some extent, but if one can see a small amount coming out of the bearing it will not only keep foreign matter from entering but also indicates a sufficient supply in ordinary cases.

The design and type of roller bearings, as well as the physical and chemical analyses of same, are points that can be discussed to great extent. The one point that can be brought out in this connection is that all manufacturers in this line have successful installations to point to, even though their constructions vary considerably.

While we have dwelled upon four-high mill construction up to this point, it must be understood that practically everything stated would also apply to other types of mills, pinion stands, drives, etc. Also, bearings of various other makes and designs have been placed on the market which have the qualities of anti-friction bearings.

STRIP STEEL

By J. H. VAN CAMPEN,
Special Engineer, Republic Steel Corporation,
Youngstown, Ohio.

We believe the Association has selected a very active subject in having papers presented on wide strip mills before the Spring Engineering Conference in Youngstown. Moreso, at this particular period, when such type of mills appear to be springing up like mushrooms.

With a total of 18 wide strip mills built and under construction at the present time and the possibility of 2 more being authorized before the end of 1935, which mills all have a roll face of 24" and

J. H. VAN CAMPEN

wider. These 20 wide strip mills will have a potential annual capacity of approximately 9,000,000 gross tons, and represent, including necessary auxiliaries, an investment to the steel companies of approximately 250 to 275 million dollars.

From this we can readily realize the importance of this subject and branch of the steel industry, and it will be of interest to hear the various papers and discussions covering the problems of rolling strip steel.

There has been no other rolling mill equipment that has had a greater and more rapid advancement than the wide hot and cold strip mill. These mills as they are built today represent the finest ingenuity known in the art of rolling mill machinery and operation, produce a product which is almost beyond conception when taking into consideration such yielding variables as analyses of material, temperatures, wear and surface, subsequent heat treatments, etc.

But with all this skilled art, high quality product, and apparent ease of operation, we believe that one of the greatest problems confronting the steel industry in view of the great number of wide strip mills producing the same class of product and the immense tonnage output, is, what radical developments other than the automotive industry will come about in the next few years that will enable the absorption of this immense production of wide strip steel.

MAINTENANCE OF ROLL NECK BEARINGS

By G. PALMGREN,
Chief Engineer, SKF Industries, Inc.
Philadelphia, Pa.

Paper to be presented at the A. I. & S. E. E. Spring Engineering Conference to be held in Youngstown, Ohio, April 24 and 25, 1935.

When discussing maintenance of roll neck bearings it must be remembered that the performance and upkeep of roller bearings on roll necks in the first place are closely related to the design of application. It must also be borne in mind that all details must be based upon a sufficient degree of practical experience.

As early as 1921, Eisenwerk Witkowitz applied SKF spherical roller bearings on the roll necks in an 11" finishing rod mill. This application was discussed in Youngstown almost ten years ago. Since then the same type of bearing has been used on the necks in over 1200 stands of all kinds of hot and cold rolling mills of all sizes up to 50" back-up roll diameter and all speeds up to 1550 R.P.M. in continuous rod mills.

It is quite natural that the problem of lubrication, maintenance and handling of the roller bearings will be quite different under so many different conditions. However, some of the main factors may be mentioned.

In the first place the design must provide for a sufficiently strong mounting. In order to know if the bearings are strong enough it is obviously necessary not only to determine the loads and all variations of loads, but also to have complete knowledge of the relation between bearing load and bearing life and how the variable load will affect the bearing life. If this part of the problem has not been handled properly from the start it is useless to discuss the maintenance because even the very best maintenance cannot eliminate mistakes in bearing design.

In spite of the great importance of the right selection of bearings it would take too long to deal with this part of the problem in detail. It may be enough to mention that our company has five laboratories where bearings are constantly tested and that we also have made 3,000 load measurements in cold rolling mills when rolling different materials and have distributed complete information regarding the results.

As already mentioned, all details in the design are of great importance for the performance, easy handling of the bearings, and rapid change of rolls. A press fit mounting on the necks, which for certain high speed applications may be deemed desirable, allows convenient mounting and dismounting of the bearing by the use of taper bores and taper necks; or, where a 4-row mounting is necessary, the use of taper roll necks and taper sleeves on which the bearings are pressed. In most cases, however, a loose fit mounting can be adopted and the evils which were encountered in the early installations of loose fit mountings and which were mainly excessive wear on the roll neck or smearing between roll necks and inner races, have been entirely overcome by providing positive lubrication of the bearing seats. Some years ago it was considered that 400 R.P.M. was the limit for a loose fit application, but today we are in a position to recommend loose fit mountings up to 1200 R.P.M. The basic principle for the successful performance of a loose fit application is that an oil film is created and maintained on the bearing seat. This oil film can be formed from an oil supply located in a central bore of the neck, which can be replenished at each roll change, and experience has shown that in a 14" merchant mill at about 100 R.P.M., this oil supply will last 200 hours. At very high speeds, as, for instance, in the finishing stands of a continuous rod mill, it is recommended that the the rolls be connected with an automatic lubricating system to insure a pre-determined amount of oil or grease to be forced under the bearing at regular intervals.

Another feature of the design which is indirectly related to the maintenance of the roller bearing application, is the locking device. Where frequent roll changes take place the method of locking should be such that it is simple to handle, and also subjected to the least possible wear. We have found no better or simpler arrangement in this respect than the use of a tapered wedge which goes through the roll neck and contacts a slotted spacer ring which is forced up against the inner race of the bearing.

Another locking device is featured in a skeleton sleeve which is locked by a nut at the center of the wobbler and which allows the muff to be pushed on the wobbler without interference from the locking sleeve. This design, made by us some years ago, has proven extremely convenient for such applications

G. PALMGREN

which refer to changeovers of existing mills where the existing roll necks were too short to allow any other locking arrangement.

Our typical roll neck application, which consists of two self-aligning roller bearings per roll neck mounted in a pivoting chock, besides giving equalized load distribution on four rows of rollers and therefore maximum capacity within the given space, also offers the interesting advantage with regard to maintenance that each of the two bearings can be considered as separate units from the standpoint of replacement. It is very unlikely that both bearings on a roll neck will fail at the same time, and with our roll neck mounting a replacement bearing can be paired with an old bearing without having to be matched at the factory.

A very important item relating to the performance and maintenance of roller bearings on roll necks, is the seal or enclosure. We can distinguish between two different types of seals: 1. Rubbing seals; 2. Labyrinth seals. The rubbing seals have the advantage when they are new to be very tight, and therefore afford a positive enclosure. However, seals of this kind must be selected with due consideration to speed as well as the amount of abrasive matter against which it is to protect the bearings. This seal also has the disadvantage that it is subjected to wear, and therefore constitutes a hazard for the bearings if they are not subjected to frequent inspections. The labvrinth seals, on the other hand, are not positively tight at any time, but maintain their sealing efficiency undisturbed at all times. It is true that a minute amount of water will leak through a labyrinth seal in a mill which is heavily water sprayed. However, the labvrinth seal has proven to be particularly effective in catching foreign matter. In view of the fact that sooner or later a small amount of water will enter into the chock (and in this connection it should be borne in mind that a certain amount of water from condensation will be present regardless of the type of seal employed), the logical step to take is to make provisions to render this water harmless to the bearings. This is exactly what we have done

by choosing a lubricant for the bearings which at the same time has the proper lubricating qualities to protect the bearings from rust. For this purpose certain grades of soda base greases will do, or a mixture of a suitable lime base grease with certain parts of emulsifying oils. In adopting this method of lubrication and sealing some ten years ago we successfully overcame the difficulties encountered from rust.

Thus maintenance is dependent upon a number of factors, and successful operation and low maintenance costs can only be obtained by proper consideration to the above outlined points.

ITEMS OF INTEREST

PERSONNEL CHANGES

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At a recent meeting of the board of directors of the Crocker-Wheeler Electric Mfg. Co., Ampere, N. J., B. D. Cristian was elected vice president.

Mr. Christian has been identified with Crocker-Wheeler for 21 years. For the past nine years he has been the general sales manager of the company and previously represented it both in the Cleveland and Chicago territories.

Before his connection with Crocker-Wheeler, Mr. Christian was the engineer of power with the Merchants Heating and Lighting Company of Indianapolis.

▲

Erle G. Hill has joined Lukens Steel Company, Coatesville, Pa., as director of research. He was born in Santa Ana, Cal., in 1890 and studied mining and metallurgical engineering at the University of California. After graduation in 1913, he took graduate work at the University of California, Carnegie Institute of Technology and the University of Pittsburgh.

Hill's early work was as a mining engineer and metallurgist in the western states and in Mexico. In 1918, he became an instructor in mining and metallurgy at the Carnegie Institute of Technology, during which time he was also a member of the staff of the Pennsylvania Geological Survey. In 1920, he became an associate professor of metallurgy at the University of Pittsburgh, serving there for ten years, during which time he also functioned as consultant for various companies in mining and metallurgical fields. He resigned in 1930 to accept a research fellowship at the Mellon Institute of Industrial Research, remaining in that work until he joined Lukens Steel Company.

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Announcement is made by the Harnischfeger Corporation of the appointment of Harry Ewert as assistant sales manager of the welder division. For the past ten years, Mr. Ewert has been identified with the production and sales of P&H Hansen welders, during which time he has been closely associated with the inventor, Mr. K. L. Hansen.

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Mr. K. I. Clisby of 74 Trinity Place, New York City was elected a vice president of The Ohio Electric Mfg. Co. at its recent annual meeting.

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Appleton Electric Company, with general offices and factory at 1701 Wellington avenue, announce the removal of their New York office from its present location at 150 Varick street to the Port Authority Commerce building, 76 Ninth avenue, New York, N. Y.

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Directors of the Blaw-Knox Company, at a recent organization meeting, created the office of chairman of the board. Albert C. Lehman, president, was elected to the new post in appreciation of his thirty years of service to the company since its inception, a resolution of the board stated.

Irvin F. Lehman, vice president, who has also been associated with the company since its early days, was elected president, and Frank Cordes was made senior vice president.

The following were re-elected: Chester H. Lehman, vice president; Robert F. McCloskey, vice president; George L. Dumbauld, treasurer; H. B. Loxterman, secretary; B. L. Hirshfield, chairman finance committee; Paul W. Keim, assistant treasurer; H. S. Strassburger, assistant treasure and assistant secretary; P. A. McCullough, comptroller.

▲

Walter E. Barnes has been appointed assistant to F. H. Gordon, vice president in charge of sales at Lukens Steel Company, Coatesville, Pa.

Barnes joined the Lukens organization in 1910. He spent six years in the mills as scale weigher, marker, layerout and recorder. In 1916, he was transferred to the order department, and in 1927, to the sales department. Subsequently, he was appointed manager of claims and then assistant to general manager of sales, in which capacity he served until his recent appointment as assistant to vice president.

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W. W. Powell, general sales manager, and J. R. Berg, general superintendent, Mesta Machine Company, at a recent meeting of the company, were elected directors. It was also announced that W. H. Seaman, formerly vice president of Continental Roll and Steel Foundry Company, has joined the company in the capacity of that of vice president in charge of roll sales.

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WITH THE MANUFACTURERS

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A new fuel flow-air flow meter recently developed by Bailey Meter Company, Cleveland, Ohio, guides operators of furnaces and kilns so that they are able to obtain maximum combustion efficiency from the fuel burned.

The primary purpose of the Bailey fuel flow-air flow meter is to provide furnace operators with

ADVERTISING PAGES REMOVED

an easily understandable guide which enables them to maintain a definite relation between the amounts of air and fuel supplied to the furnace, thereby securing the highest possible combustion economy. The meter contains two recording pens, one records the rate of oil flow or gas flow and is actuated by a simple mechanical mechanism which receives its motive power from the differential pressure produced by an orifice in the fuel line. In a similar manner the second pen records the flow of air spplied for combustion.

At the time the meter is installed, a complete combustion test is made to determine the ratio between fuel flow and air flow, which results in best combustion conditions. After this ratio is determined, the air flow mechanism is adjusted so that the two records coincide, one upon the other, when best combustion conditions are obtained. The furnace operator therefore, has merely to keep the two pens together for proper manipulation of the air supply to secure the desired economy of fuel consumption.

Should the air flow pen be above the fuel flow pen, it is an indication that too much air is being supplied with a consequent increase of stack losses. Conversely, should the air flow pen be below the fuel flow pen, it is an indication that too little air is being supplied with consequent loss due to unburned fuel.

In addition to serving as a combustion guide, the ratio meter is valuable as a fluid meter on the fuel line. It records and indicates the rate of flow in any convenient terms and the total flow may be given by a six unit integrator, which is as easily read as an automobile mileage register. In this manner, the meter furnishes a daily graphic picture of furnace operation and spplies data for cost-accounting systems.

The meter is mounted in a sturdy pressed steel casing, which is suitable for either flush front or surface mounting. The integrating mechanism requires a supply of alternating current with regulated frequency, although the meter may be furnished with a spring driven clock for the recording mechanism if an integrator is not desired in cases where frequency is not regulated.

The Bailey fuel flow-air flow meter has been designed so that auxiliary recorders of temperature or pressure may be included to record on the same chart with the flow record. This feature makes comparison of related factors a simple task, especially since the 12-inch diameter charts are uniformly graduated and are marked with direct-reading scales. Each factor is recorded in an individual color so that it can be easily distinguished from other factors.

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Allison J. Thompson, President, The Thompson Electric Company, Cleveland, Ohio, has recently issued another booklet in the series of articles on economic subjects he has been writing the past few years. The subject of this pamphlet is "The Relation of Price to Money". Those who would care to receive a copy of this may address Mr. Thompson at his Cleveland office.

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What is believed to be the heaviest single-car shipment ever made left the Schenectady Works of the General Electric Company on March 21 for its destination at the Potomac Electric Light and Power Company at Benning, D. C. The load consisted of a generator shaft, rotor, and poles for a 25,000-kilowatt frequency converter set, with a total weight of 367,000 pounds. The converter will be used to deliver 25-cycle single-phase power to the Pennsylvania Railroad.

Through routing of this extraordinary load required the use of the tracks of the Delaware and Hudson, the Pennsylvania, and the Western Maryland railways; clearances over the regular route between Schenectady and Benning being limited by the dimensions of the tunnels in the city of Baltimore.

Arrangements for the shipment required several months. All routes between shipping point and destination were checked, and when the route with the greatest clearance had been selected, a check of practically every foot of the way was made to determine if a temporary removal of obstructions could be made to allow the load to pass.

From Schenectady to Wilkes-Barre, Pa., special train movement was resorted too—the load being taken from point to point only when north-bound traffic could be avoided. All cars were cleared from sidings and even switch lamps and switch stands had to be removed in several instances.

From Wilkes-Barre, the load went to Hagerstown, Md., by way of the Pennsylvania, where it was turned over to the Western Maryland Railway. After an extensive detour, it was delivered back to the Pennsylvania south of the Baltimore tunnels, whence it was carried to the customer's siding at Benning.

Not only was it necessary to check the height and width through bridges, tunnels, and underpasses, but also to examine the roadbed and bridge and culvert strength along the entire route because of the extremly high concentration of weight on the rails. For movement over the customer's siding, shoring-up and realigning of tracks were necessary.

The dimensions of the load when skidded, covered, braced, and placed on the car were 17 feet above the rails with an 8-foot width, and 14 feet above the rails with a 12½-foot width. Only six cars in the country were of the right type and capacity to carry such a load—and car NYC-499041 was used. This car has four 2-axle trucks, alone weighs, 104,100 pounds, and has a carrying capacity of 200 tons. As loaded at Schenectady, the total weight on the rails was 471,100 pounds.

The entire movement of this record single-car load took place under the constant supervision of General Electric and the engineering departments of the railroads concerned.

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Benjamin Electric Mfg. Co., Des Plaines, Illinois, has placed on the market a new line of mercury vapor lamp fixtures, designed for general interior lighting and also for the more special lighting of high narrow rooms.

These new vapor lamp fixtures are essentially high intensity units. They are made to give a lot of light, properly diffused and directed, and are ruggedly made to stand hard shop service for a long time.

Both the aluminum and porcelain enamel fixtures use a standard 400-watt high intensity mercury vapor lamp. Both are furnished, as desired, with Benjamin "Socket-Reflector" construction or with the patented Benjamin "Turnlox" feature, which permits removal of lamp and reflector as a single unit for easy cleaning on the floor or at a bench.